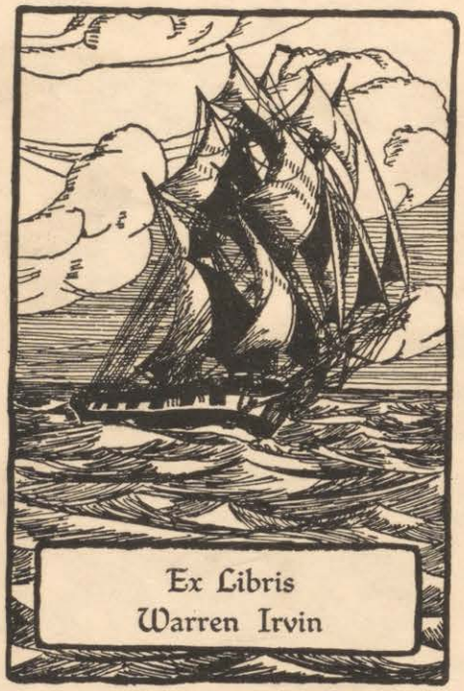
POLITICAL ESSAY ON THE KINGDOM OF NEW SPAIN

HUMBOLDT

III



MAP

Of the Valley of Mexico

And Neighbouring Mountains
Sketched on the Spot in 1804 by Don Louis Martin,
and New modelled and corrected in 1807
from the Trigonometrical operations of
Don Joaquin Velasquez,
and the Astronomical observations, and Barometrical
measurements of M. de Humboldt.

By JABBO OLTMANNS.

The Canal of Huehuetoca conducts the waters of the Rio de Guautitlan by the Rio de Tula or Moctezuma and the Rio de Panuco to the Atlantic Ocean. — The Canals of Zumpango (D.F) and San Christobal (B.F.C) were added in 1796 & 1798. — The small Canal of Vertideros (D.E) serves to throw the Desague dry. — The Canals (A.B) were projected to remove the danger to which the City of Mexico is still exposed of inundations from the South and East.
Humboldt.

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W. Lowry Sc.

POLITICAL ESSAY

ON THE

KINGDOM OF NEW SPAIN.

VOL. III.

LONDON:
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To General Carrera with
Mr Rennie's
Compliments

POLITICAL ESSAY

ON THE

KINGDOM OF NEW SPAIN.

CONTAINING

Researches relative to the Geography of Mexico,
The Extent of its Surface and its political Division into Intendancies,
The physical Aspect of the Country,
The Population, the State of Agriculture and Manufacturing
and Commercial Industry;
The Canals projected between the South Sea and Atlantic Ocean,
The Crown Revenues,
The Quantity of the precious Metals which have flowed from Mexico
into Europe and Asia, since the Discovery of the
New Continent,
And the Military Defence of New Spain.

By ALEXANDER DE HUMBOLDT.

WITH

PHYSICAL SECTIONS AND MAPS,

FOUNDED ON ASTRONOMICAL OBSERVATIONS, AND TRIGONOMETRICAL AND BAROMETRICAL MEASUREMENTS.

TRANSLATED FROM THE ORIGINAL FRENCH

By JOHN BLACK.

VOL. III.

LONDON:
PRINTED FOR
LONGMAN, HURST, REES, ORME, AND BROWN,
PATERNOSTER-ROW.
1822.

ADVERTISEMENT.

THE conclusion of Humboldt's Political Essay on New Spain is now laid before the Public. The Translator in these concluding volumes has continued to convert the weights, measures, and coins of the original, into those used in England, with all the accuracy in his power; but he has cautiously and perhaps prudently abstained from taking notice of any seeming oversight or inconsistency of M. de Humboldt, occurring to him in the course of translation. It is hardly possible for a Translator of the most obtuse intellect not occasionally to perceive a vulnerable point in his original; and what the present Translator perceives, or imagines he perceives, he is at no time

very willing to keep locked up from others; but whether from his former notes being intrinsically without merit, or from its being expected that so humble a being as a Translator, should steer at as great a distance as possible from the higher parts of authorship, the Translator candidly confesses that the reception of these notes, so far as he has had occasion to learn, was not such as to induce him to resume the office of Commentator.

From an idea that the weights used in the original, where the contrary was not expressly stated, were French, the Translator uniformly considered marcs to mean marcs of France; and it was not till near the end of the third volume, he discovered that the author meant marcs of Castille, which are to the French as 541 to 576: the conversions of marcs therefore, as far as page 394 of the third volume, are all in a slight degree erroneous, and to be reduced to accuracy require to be multiplied by .93923.

The Translator in printing a list of Errata has no doubt that it might be easily increased by an attentive and intelligent reader. Those who know the difficulty of carrying a work through the press with a tolerable degree of correctness, will not perhaps be the most forward to accuse him of inaccuracy.

BOOK IV.

CHAPTER X.

Plants supplying raw materials for manufactures and commerce.—Rearing of cattle.—Fisheries.—Agricultural produce estimated from the value of the tithes.

Although the Mexican agriculture, like the agriculture of every country which supplies the wants of its own population, is principally directed towards alimentary plants; New Spain, however, is not less rich in those commodities exclusively called *Colonial;* that is to say, in the productions which supply raw materials for the commerce and manufacturing industry of Europe. That vast kingdom unites, in this point of view, the advantages of New England with those of the West India Islands. It is beginning in a particular manner to enter into competition with these islands, now that the civil war of St. Domingo, and the devastation of the French sugar colonies have rendered the cultivation of colonial commodities more profitable on the continent of Ame-

rica. It is even observable that in Mexico this species of cultivation has made a much more considerable progress than that of corn. In these climates, the same extent of ground, for example, an acre of 5368 square metres *, yields to the cultivator from 80 to 100 francs in wheat, 250 francs in cotton, and 450 francs in sugar.† The difference in the value of the produce being then so enormous, we ought by no means to wonder that the Mexican colonist gives to colonial commodities a preference over barley and wheat. But this predilection will never disturb the equilibrium which has hitherto existed between the different branches of agriculture, because, fortunately, a great part of New Spain, situated under a climate more cold than temperate, is unfit for the production of sugar, coffee, cocoa, indigo, and cotton.

The cultivation of the sugar-cane has made such rapid progress within these last years, that the exportation of sugar at the port of Vera Cruz actually amounts to more than

* 57,780 square feet. *Trans.*

† This estimate is looked upon as the most exact by the colonists of Louisiana near New Orleans. They calculate on 20 bushels of wheat, 250 pounds of cotton, and 1000 pounds of sugar per acre. This is the mean produce; but it may be easily conceived that these results must be modified by a number of local circumstances.

half a million of arrobas, or 6,250,000 kilogrammes *, which at three piastres the arroba, is equal to seven millions and a half of francs.† We have already observed that the ancient Mexicans were only acquainted with the sirop of honey, that of the *metl* (agave) and the sugar of maize cane. The sugar-cane, cultivated from the remotest antiquity in the East Indies, in China‡, and in the South Sea Islands, was imported by the Spaniards, from the Canary Islands into the Island of St. Domingo, from whence it was successively introduced into the Island of Cuba and New Spain. Peter D'Atienza planted the first sugar-canes about the year 1520 § in the environs of the town of Conception de la Vega. Gonzalo de Velosa constructed the first cylinders; and in 1535, more than 30 sugar works were already established in the island of St. Domingo, of which many were served by a hundred Negro slaves,

* 13,793,750 lb. avoird. *Trans.*

† 312,525*l.* sterling. *Trans.*

‡ I am even tempted to believe that the process used by us in the making of sugar, has been brought from Oriental Asia. I recognized at Lima, in Chinese paintings representing the arts and trades, cylinders placed horizontally, and put in motion by a mill, cauldrons and purifying apparatus such as are now to be seen in the West Indies.

§ Not in 1506, as is generally said.—Oviedo, who came to America, in 1513, says expressly, that he saw the first sugar works established at St. Domingo. (*Historia natural de Indias*, lib. iv. c. 8.)

and cost from 10 to 12 thousand ducats in expense of erection. It is remarkable enough that among the first sugar mills (*trapiches*) constructed by the Spaniards in the beginning of the 16th century, some of them were already put in motion not by horses, but by hydraulical wheels, although these same water mills (*trapiches*) or molinos de agua, have been introduced in our days into the Island of Cuba, as a foreign invention, by refugees from Cape François.

In 1553 the abundance of sugar was already so great in Mexico, that it was exported from Vera Cruz and Acapulco into Spain and Peru.* This last exportation has long ceased, as Peru produces now more sugar than is necessary

* "Besides gold and silver, Mexico furnishes also much sugar and cochineal, two very precious commodities, feathers and cotton.—Few Spanish vessels return without a cargo, which is not the case in Peru, that has however falsely the reputation of being richer than Mexico. This last country has also preserved a much greater number of its inhabitants. —It is a very fine and very populous country, to which nothing is wanting but more frequent rains.—New Spain exports to Peru, horses, beef, and sugar."—This remarkable passage of Lopez de Gomara, who describes so well the state of the Spanish Colonies towards the middle of the 16th century, is only to be found in the edition *de la conquista de Mexico*, published at Medina del Campo, 1553, fol. 139. It is wanting in the French translation printed at Paris in 1587, p. 191.

for its own consumption. As the population of New Spain is concentrated in the interior of the country, we find fewer sugar works along the coast, where the great heats and abundant rains are favourable to the cultivation of the sugar, than on the ascent of the Cordilleras, and in the more elevated parts of the central table land. The principal plantations are in the intendancy of Vera Cruz, near the towns of Orizaba and Cordova; in the intendancy of Puebla, near Guautla de las Amilpas, at the foot of the Volcan de Popocatepetl; in the intendancy of Mexico, to the westward of the Nevado de Toluca, and to the south of Cuernavacca, in the plains of San Gabriel; in the intendancy of Guanaxuato, near Celaya, Salvatierra, and Penjamo, and in the valley of Santiago; in the intendancies of Valladolid and Guadalaxara, to the south-west of Pazcuaro and Tecolotlan. Although the mean temperature most suitable to the sugar-cane is 24° or 25° of the centigrade thermometer *, this plant may however be successfully cultivated in places where the mean annual heat does not exceed 19° or 20°.† Now the decrease of the caloric being nearly a degree of the centigrade thermometer for every 200 metres‡ of elevation, we find in general,

* From 75° to 77° of Fahrenheit. *Trans.*
† From 66° to 68° of Fahrenheit. *Trans.*
‡ 200 metres = 656 English feet. *Trans.*

under the tropics, on the rapid declivity of mountains, this mean temperature of 20° at 1000 metres of elevation* above the level of the ocean. On table land of a great extent, the heat is increased to such a degree by the reverberation of the earth, that the mean temperature of the city of Mexico is 17° instead of 13°. 7†; that of Quito, is 15°. 8 instead of 11°. 5.‡ The result of these data is, that, on the central table land of Mexico, the maximum of heat at which the sugar-cane vegetates vigorously without suffering from frost in winter, is not 1000 but from 1400 to 1500 metres.§ In favourable exposures, especially in valleys sheltered by mountains from the north winds, the highest limit of sugar cultivation reaches as high as 2000 metres. In fact, if the height of the plains of San Gabriel, which contain many fine sugar plantations, is only 980 metres; on the other hand the environs of Celaya, Salvatierra, Irapuato and Santiago, are beyond 1800 metres of absolute elevation. I have been assured that the sugar-cane plantations of Rio Verde, situated to the north of Guanaxuato under 22° 30′ of latitude, are at an elevation of 2200 metres‖, in a narrow valley surrounded by high Cordil-

* 3280 feet. *Trans.*
† 62° 6 and 56° 6 of Fahr. *Trans.*
‡ 60° 4 and 52° 9 of Fahr. *Trans.*
§ From 4592 to 4920 feet. *Trans.*
‖ 7211 feet. *Trans.*

leras, and so warm that its inhabitants frequently suffer from intermittent fevers. I discovered, on examining the testament of Cortez*, that in the time of this great man there were sugar works near Cuyoacan in the valley of Mexico. This curious fact proves what is indicated by several other phenomena, that this valley is colder in our days than it was at the commencement of the conquest, because a great number of trees then diminished the effect of the north winds which now blow with impetuosity. Those accustomed to see sugar-cane plantations in the West India Islands, will learn with the same astonishment, that in the kingdom of New Granada the greatest quantity of sugar is not yielded in the plains, on the banks of the river de la Madalena, but on the ascent of the Cordilleras, in the valley of Guaduas, on the road from Honda to Santa Fe, in a district, which, according to my barometrical measurement, is from 1200 to 1700 metres† above the level of the sea.

* "I order an examination to be made whether in my *estados* lands have been taken from the natives to be planted with vines; I wish also an examination to be made as to the ground given by me in these last years to my domestic Bernardino del Castillo for the establishment of a sugar plantation near Cuyoacan." (*Manuscript Testament of Hernan Cortez, executed at Seville, the 18th August*, 1548, *art.* 48.)

† From 3936 to 5576 feet. *Trans.*

Fortunately the introduction of negroes has not augmented in Mexico in the same proportion as the sugar produce. Although in the intendancy of Puebla, near Guautla de las Amilpas, there are plantations (*haciendas de cañ'a*) which yield annually more than from twenty to thirty thousand arrobas * (from 500,000 to 750,000 kilogrammes †) almost all the Mexican sugar is manufactured by Indians, and consequently by free hands. It is easy to foresee that the small West India Islands, notwithstanding their favourable position for trade, will not be long able to sustain a competition with the continental colonies, if the latter continue to give themselves up with the same ardour to the cultivation of sugar, coffee, and cotton. In the physical as well as in the moral world, every thing terminates in a return to the order prescribed by nature; and if small islands, of which the population was exterminated, have hitherto carried on a more active trade with their productions than the neighbouring continent, it is only because the inhabitants of Cumana, Caracas, New Granada, and Mexico began very late to profit by the immense advantages derived by them from nature. But roused from a lethargy of many ages, freed from the shackles which a false policy imposed on the progress of agriculture, the Spanish colonies of the continent will gradually take possession of the different branches of the West India trade. This change, which has been prepared by the events of St. Domingo, will have the most fortunate issue in the diminution of the slave trade; and suffering humanity will owe to the natural progress of things what we had a right to expect from the wisdom of the European governments. Thus the colonists of the Havannah, well informed as to their true interests, have their eyes fixed on the progress of sugar cultivation in Mexico, and the coffee of the Caracas. They have long dreaded the rivalship of the continent, especially since the want of combustibles, and the excessive dearth of provisions, slaves, metallic utensils, and the necessary cattle, have considerably diminished the net revenue of the plantations.

New Spain, besides the advantage of its population, has still another very important one in the enormous mass of capitals in the possession of the proprietors of mines, or in the hands of merchants who have retired from commerce. In order fully to feel the importance of this advantage, we must recollect that in

* This produce is very considerable, and it is only to be found in a single plantation in the Island of Cuba, of the name of *Rio Blanco*, belonging to the Marquis *del Arcos*, between Xaruco and Matanzas, which annually produces 40,000 arrobas of sugar. There are not eight which yield for ten years in succession 35,000.

† From 1,103,500 to 1,655,250 lb. avoird. *Trans.*

the island of Cuba, the establishment of a great sugar plantation, worked by 300 negroes, and yielding annually 500,000 kilogrammes * of sugar, requires an advance of two millions of livres tournois †, and that it brings in from 300,000 to 350,000‡ livres of revenue. The Mexican colonist may choose along the coast, and in the valleys of greater or less depth, the most suitable climate for the sugar-cane; and he has less to fear from frost than the colonist of Louisiana. But the extraordinary configuration of the surface of New Spain throws great obstacles in the way of transporting sugar to Vera Cruz. The plantations now in existence are for the most part very remote from the coast opposite to Europe. The country having yet neither canals nor roads fit for carriage, the mule carriage of the sugar to Vera Cruz increases its price a piastre per arroba, or eight sous per kilogramme.§ These obstacles will be much diminished by the roads now making from Mexico to Vera Cruz by Orizaba and by Xalapa, along the eastern slope of the Cordilleras. It is also probable that the progress of colonial agriculture will contribute to people the shores of New Spain,

* 1,103,500 lb. avoird. *Trans.*
† 83,340*l.* sterling. *Trans.*
‡ From 12,500*l.* to 14,581*l.* sterling. *Trans.*
§ About 3d. per 2 lb. avoird. *Trans.*

which for ages have remained desert and uncultivated.

It is observed in Mexico, that the *vezou*, or juice expressed from the sugar cane is more or less sugary, according as the plant grows in the plain, or on an elevated table land. The same difference exists in the cane cultivated at Malaga, the Canary Islands, and the Havannah. The elevation of the soil every where produces the same effects on vegetation, as the difference of geographical latitude. The climate has also an influence on the proportion between the quantities of liquid and crystallizable sugar contained in the juice of the cane; for sometimes the *vezou* has a very sweet savour, and yet crystallizes with great difficulty. The chemical composition of the *vezou* is not always the same, and the excellent experiments of M. Proust have thrown great light on the phenomena discoverable in the American sugar works, many of which are to the sugar refiner the cause of great despondency.

From the most exact calculations that I could make at the island of Cuba, I find that a given hectare of ground yields for mean term 12 cubic metres of *vezou*, from which is drawn by the processes hitherto in use, in which much sugary matter is decomposed by fire, at most from ten to twelve per cent. or 1500 kilogrammes * of raw sugar. They reckon at

* 3310 lb. avoird. *Trans.*

the Havannah, and in the warm and fertile parts of New Spain, that a *caballeria* of ground which contains 18 square *cordeles* (at 24 *varas*), or 133,517 square metres *, yields annually 2000 *arrobas* or 25,000 kilogrammes. † The mean produce, however, is only 1500 arrobas, which is 1400 kilogrammes of sugar per hectare. ‡ At St. Domingo, the produce of a *carreau* of ground containing 3403 toises, or 12,900 § square metres is estimated at 4000 pounds, which is equal to 1550 kilogrammes per hectare. Such is, in general, the fertility of the soil of equinoctial America, that all the sugar consumed in France, which I estimate at 20 millions of kilogrammes ‖, might be produced on a surface of 7 square leagues ¶, an extent which

* 1,437,163 square feet. *Trans.*

† Upwards of 50,000 lb. avoird. *Trans.*

‡ 3089 lb. avoird. p. 107,639 square feet. *Trans.*

§ 138,854 square feet. *Trans.*

‖ 44,140,000 lb. avoird. *Trans.*

¶ France drew from her Colonies in 1788 a total of 872,867 quintals of raw sugar, 768,566 of clayed sugar, and 242,074 of *sucre tête.** Of this quantity, according to M. Peuchet, only 434 thousand quintals of refined sugar were consumed in the kingdom. We learn from the lists published during the ministry of M. Chaptal, that the importation of sugar amounted in France in the year 9, to 515,100 quintals.

* *Sucre tête* or sucre de tête is that which is taken from the upper part or head of the conical pot or pan (*forme*) used in the making of clayed sugar. (*Casaux sur l'Art de cultivez la Canner*, p. 453.) *Trans.*

is not the thirtieth part of the smallest department of France.

In grounds capable of being watered, and in which plants with tuberous roots, for example *batates* and *ignames*, have preceded the cultivation of the sugar-cane, the annual produce amounts even to three or four thousand arrobas per *caballeria*, or to 2100 and 2800 kilogrammes of raw sugar per hectare. Now, in estimating an arroba at three piastres, which is the mean price at Vera Cruz, we find from these data, that a hectare of irrigated ground, will yield to the amount of 2500 or 3400 livres tournois in sugar *, while the same hectare would only yield to the value of 260 livres in wheat, supposing a decuple return, and estimating 100 kilogrammes of wheat at 1600 livres tournois. In drawing a comparison between these two species of cultivation, we must never forget, that the advantages of the sugar-cane cultivation are very much diminished, by the enormous advances required in the establishment of a sugar plantation.

The greatest part of the sugar produced in New Spain, is consumed in the country. The consumption probably amounts to more than 16 millions of kilogrammes †; for that of the island of Cuba, undoubtedly amounts to from 25 to 30,000 chests (*caxas*) of 16 ar-

* From 104*l.* to 141*l.* p. 107,639 square feet. *Trans.*

† Upwards of 35 millions of pounds avoird. *Trans.*

robas or 200 kilogrammes. Those who have not seen with their own eyes the enormous quantity of sugar consumed in Spanish America, even in the poorest families, will be astonished to hear, that the whole of France demands for its own wants only three or four times as much sugar as the island of Cuba, of which the free population does not exceed the number of 340,000 inhabitants.

I have endeavoured to bring together in one view, the exportation of sugar from New Spain, and that from the West India Islands. It was impossible for me to reduce all its data to the same period. I could not procure certain information, as to the actual produce of the English islands, which has prodigiously increased. The island of Cuba exported in 1803, from the port of the Havannah, 158,000 *caxas*, and from the port of the Trinity and Santiago de Cuba, including the contraband 3000 caxas: Hence—

	Kilogr.
Total exportation of Sugar from the Island of Cuba - - - -	37,600,000
Exportation of Sugar from New Spain, 500,000 arrobas, in 1803 - - -	6,250,000
Exportation from Jamaica, in 1788 - -	42,000,000
Exportation from the English Virgin Islands and Antigua, in 1788 - - -	49,610,000
Exportation from St. Domingo, in 1788 -	82,000,000
——————————— in 1799 -	20,400,000

I believe we may admit, that the whole of the American islands actually supply Europe

with more than 200 millions of kilogrammes of raw sugar, of which the value even in the colonies, is 40 millions of piastres, or more than 200 millions of livres tournois *, estimating the *caxa* at 40 double piastres. Three causes have concurred to prevent the rise of this colonial commodity, since the destruction of the plantations of St. Domingo; namely the introduction of the sugar-cane of Otaheite, which on the same extent of ground yields a third more *vezou* than the common cane; the progress of agriculture on the coast of Mexico, Louisiana, Caracas, Dutch Guyana, and Brazil; and lastly the importation of sugar from the East Indies into Europe.

This importation especially ought to fix the attention of those who reflect on the future direction of commerce. Ten years ago, the Bengal sugar was as little known in the great market of Europe, as the sugar of New Spain, and now both of them compete with the sugar of the West India Islands.

The United States have received sugar from Asia, as follows—

	In 1800	In 1801	In 1802
	Kilogr.	Kilogr.	Kilogr.
From Manilla - -	216,452	403,389	646,461
From China and the East Indies -	310,020	387,204	574,939
Total	526,472	790,593	1,221,400

* 8 millions sterling. *Trans.*

The great fertility of the soil, and the immense population, gives such great advantages to Bengal over every other country of the globe, that the sugar exported from Calcutta, after a passage of 5200 leagues, is still lower at New York than the Jamaica sugar, which comes only from a distance of 860 leagues. This phenomenon will not appear so astonishing, to whoever casts his eye over the table given by me in a former part of the work, of the wages of labour * in the different countries of the world, and who reflects that the sugar of Hindostan, which is not however of the greatest purity, is manufactured by free hands, while in the West India islands (in the island of Cuba for example) to produce 250,000 kilogrammes of raw sugar, requires 200 negroes, whose purchase amounts to more than 300,000 francs.† In the same island the maintenance of a slave costs more than 20 francs per month.‡

According to the curious information given by M. Bockford in his *Indian Recreations*,

* According to Mr. Playfair, (*Statistical Breviary* 1801, p. 60.) the price of labour in Bengal is as follows: a mere workman gains 12 shillings per month; a porter 15; a mason $18\frac{3}{4}$; a blacksmith or carpenter $22\frac{1}{2}$; an Indian soldier 20: all in the environs of Calcutta, reckoning the English shilling at 25 French sous, and the rupee at two shillings and sixpence.

† 12,501*l.* sterling. *Trans.*

‡ 16*s.* 8*d.* *Trans.*

printed at Calcutta, the sugar cane is cultivated in Bengal, principally in the districts of Peddapore, Zemindar, in the Delta of Godavery, and on the banks of the river Elyseram. The plantations are watered there, as is also customary in several parts of Mexico, and in the valley of Guines, to the south-east of the Havannah. To prevent the soil from being exhausted, they cultivate alternately leguminous plants with the sugar cane, which attains in general three metres of elevation, and from three to four centimetres in thickness.* In Bengal, an acre (of 5368 square metres) yields 2500 kilogrammes of sugar†, amounting to 4650 kilogrammes per hectare: consequently the produce of the soil is twice as great as that of the West Indies, while the price of the labour of a free Indian, is almost three times less than that of a negro slave of the Island of Cuba. In Bengal, six pounds of the juice of the cane yield a pound of crystallized sugar, while in Jamaica eight pounds are requisite to produce the same quantity of sugar. Considering the *vezou* as a liquid charged with salt, we find that in Bengal this liquid contains 16, and in Jamaica 12 per cent. of saccharine matter. Hence the sugar of the East Indies is so low priced, that the cultivator

* 9 feet 10 inches, by from 11 to 15 inches. *Trans.*

† 5517 lb. avoird. *Trans.*

sells it at 4½ roupees the quintal, or at 26 centimes the kilogramme, which is nearly the third of the value of that commodity in the Havannah market. Although the cultivation of the sugar cane is spreading with astonishing rapidity in Bengal, the total produce is still much less than that of Mexico. Mr. Bockford supposes the produce of Jamaica to be the quadruple of that of Bengal.

Cotton is one of those plants of which the cultivation was as antient among the Aztec tribes, as that of the pite, the maize, and the quinoa. There is some of the finest quality on the western coast, from Acapulco to Colima, and at the port of Guautlan, particularly to the south of the Volcan de Jorullo, between the villages of Petatlan, Teipa, and Atoyaque. As they are yet unacquainted with machines for separating the cotton from the seed, the price of carriage is a great obstacle in the way of this branch of Mexican agriculture. An *arroba* of cotton (*Algodon con peppa*) which sells for 8 francs at Teipa, costs 15 at Valladolid, on account of the mule carriage. That part of the eastern coast extending from the mouths of the rivers Guasacualco and d'Alvarado, to Panuco, might supply the commerce of Vera Cruz with an enormous quantity of cotton; but the coast is almost uninhabited, and the want of hands occasions a dearth of provisions,

unfavourable to every agricultural establishment. New Spain supplies Europe annually with only 25,000 *arrobas*, or 312,000 kilogrammes * of cotton. This quantity though in itself very inconsiderable, is however six times greater than that exported by the United States, of their own growth in 1791, according to the information which I owe to the kindness of M. Gallatin, Finance Minister at Washington. But the rapidity of the increase of industry, among a free people wisely governed, is so great, that according to a note furnished me by the same statesman, the United States exported,

	Home Cotton.	Foreign Cotton.
In 1797	2,500,000 lib.	1,200,000 lib.
1800	3,660,000	14,120,000
1802	3,400,000	24,100,000
1803	3,493,544	37,712,079.

From these data of M. Gallatin, it follows that the produce of cotton has become 377 times greater in twelve years. When we consider the physical positions of the United States and Mexico, we can hardly entertain a doubt that these two countries will one day be enabled to produce all the cotton employed in the manufactures of Europe. The enlightened merchants who compose the chamber of commerce of Paris, have asserted in a memoir

* 688,584 lb. avoird. *Trans.*

printed a few years ago, that the total importation of cotton into Europe, amounts to 30 millions of kilogrammes.* I am inclined to believe that this estimate is much below the truth; for the United States alone have exported annually, more than 22 millions of kilogrammes of cotton †, amounting in value to 7,920,000 dollars, or nearly 40 millions of livres tournois.

Flax and *hemp* may be advantageously cultivated wherever the climate does not admit of the cultivation of cotton, as in the *provincias internas*, and even in the equinoctial region or table land, where the mean temperature is under 14 degrees of the centigrade thermometer. ‡ The Abbe Clavigero advances that flax is to be found wild in the intendancy of Valladolid and in New Mexico, but I very much question whether the assertion is founded on the accurate observation of any botanical traveller. However it is certain that neither flax nor hemp have to this day been cultivated in Mexico. Spain has had a few enlightened ministers who wished to favour these two branches of colonial industry; but their favour was nothing more than temporary. The council of the Indies, whose influence is durable like that of every body in which

* 62,100,000 lb. avoird. *Trans.*
† 48,558,000 lb. avoird. *Trans.*
‡ 57° of Fahrenh. *Trans.*

the same principles are perpetuated, have ever wished the mother country to oppose the cultivation of flax, the vine, the olive, and the mulberry. Unenlightened as to its true interests, the government has always preferred seeing the Mexican people clothed with cotton purchased at Manilla and Canton, or imported at Cadiz by English vessels, to the production of the manufactures of New Spain. It is to be hoped that the mountainous part of Sonora, the intendancy of Durango and New Mexico, will one day rival Galicia and the Asturias in the production of flax. As to hemp, it would be of importance not to introduce into Mexico the European species, but that which is cultivated in China (*cannabis indica*), of which the stalk grows to the height of five or six metres.* We have every reason to presume, however, that the cultivation of flax and hemp will spread with great difficulty in that region of Mexico abounding with cotton. The *steeping* requires more care and labour than the separation of cotton from the seed; and in a country where there are few hands, and much laziness, the preference is naturally given to a cultivation of which the produce is much more promptly and easily managed.

The cultivation of coffee in the Island of Cuba,

* 16 or 19 feet. *Trans.*

and the Spanish colonies on the continent, commenced only since the destruction of the plantations of Saint Domingo.* In 1804 the Island of Cuba produced already 12,000, and the province of Caracas nearly 5,000 quintals. New Spain possesses sugar plantations in greater number, and more considerable than Terra Firma possesses; but the production of coffee amounts yet to nothing, though it can hardly be doubted that this species of cultivation would succeed perfectly well in the temperate regions, particularly at the elevation of the towns of Xalapa and Chilpansingo. The use of coffee is still so rare in Mexico, that the whole country does not consume annually more than four or five hundred quintals; while the consumption of France, where the population is scarcely five times

* The French part of St. Domingo produced in 1783 only 445,734 quintals of coffee; but five years afterwards it produced 762,865. And yet the price in 1783 was 50 francs the quintal, and 94 francs in 1788; which proves how much the use of coffee has been spreading in Europe notwithstanding the advanced price. Yemen furnishes annually according to Raynal 130,000, and according to Mr. Page 150,000 quintals, which are almost all exported to Turkey, Persia, and India. The Isles of France and Bourbon yield 45,000 quintals. It appears to me, from what information I have been able to procure, that all Europe actually consumes annually, nearly 53 millions of kilogrammes of coffee (116,971,000 lbs. avoird. *Trans.*) The coffee-tree yields in a good soil one kilogramme of coffee, and 960 of them may be planted on a hectare of ground.

greater than that of New Spain, amounts to nearly 230,000 quintals.

The cultivation of the cocoa-tree (*cacari* or *cacava quahuitl*) had already made considerable progress in Mexico in the time of Montezuma; and it was there where the Spaniards obtained a knowledge of that precious tree, which they afterwards transplanted into the Canary and Philippine Islands. The Mexicans prepared a beverage called by them *chocolatl*, in which a little maize flour, *vanilla* (*tlilxochitl*) and the fruit of a species of spice (*mecaxochitl*) were mixed with the cocoa (*cacahuatl*).* They could even reduce the chocolate to cakes, and this art, the instruments used in grinding the cocoa, as well as the word *chocolatl*, have been transferred from Mexico to Europe. This is so much the more astonishing, as the cultivation of the cocoa is now almost totally

* *Hernandez*, lib. ii. c. 15; lib. iii. c. 46; lib. v. c. 13. In the time of Hernandez, they distinguished four varieties of cocoa, called *quauhcahuatl*, *mecacahuatl*, *xochicucahuatl*, and *tlalcacahuatl*. This last variety had a very small seed: the tree which produced it bore an analogy undoubtedly to the cocoa, which we found growing wild on the banks of the Orinoco, to the east of the mouth of the Yao. The cocoa tree cultivated for centuries, has a larger, sweeter, and more oily seed. We must not confound with the *Theobroma Cacao* the *T. bicolor*, of which I have given a drawing in our *Plantes equinoxiales* (*t. i. pl.* xxx. *a. et b. p.* 104.) and which is peculiar to the Province of Choco.

neglected. With difficulty we can find a few of these trees in the environs of Colima, and on the banks of the Guasacualco. The cocoa plantations in the Province of Tabasco are very inconsiderable; and Mexico draws all the cocoa necessary for its consumption from the Kingdom of Guatimala, Maracaybo, Caracas, and Guayaquil. This consumption appears to amount annually to 30,000 *fanegas*, of the weight of 50 kilogrammes each.* The Abbe Hervas maintains that the whole of Spain consumes 90,000 *fanegas*. † The result of this estimate, which appears to me too low, is, that Spain only consumes the third part of the coffee annually imported into Europe. But according to the enquiries made by me on the spot, from 1799 to 1803, I found the annual exportation of coffee to be,

	Fanegas.
In the Provinces of Venezuela and Maracaybo -	145,000
In the Province of New Andalusia (Cumana) -	18,000
In the Province of New Barcelona - - -	5,000
In the Kingdom of Quito, from the Port of Guayaquil - - - - -	60,000

The value of these eleven millions and a half of kilogrammes of cocoa, amounts in Europe in time of peace, estimating the *fanega* at only 40 piastres, to the sum of 45,600,000

* 110 lb. avoird. *Trans.*

† *Idea del Universo*, t. i. p. 174.

livres tournois.* In the Spanish Colonies, chocolate is not considered an object of luxury, but of prime necessity. It is, in fact, a very healthy and nutritive aliment, and is of particular assistance to travellers. The chocolate prepared at Mexico is of a superior quality, because the commerce of Vera Cruz and Acapulco, brings into New Spain the famous cocoa of Soconusco, (*Xoconochco*) from the coast of Guatimala; the cocoa of *Gualan* from the gulph of Honduras near Omoa; of *Uritucu* near St. Sebastian, in the province of Caracas; of *Capiriqual* in the province of New Barcelona; and of *Esmeralda* in the kingdom of Quito.

In the time of the Aztec kings, cocoa seeds were made use of as money in the great market of Tlatelolco, as shells were in the Maldivian Islands. The cocoa of Soconusco, cultivated at the eastern extremity of the Mexican Empire, was used for chocolate, and the small seed called *Tlalcacahuatl*. The kinds of inferior quality were used for money. "Knowing," says Cortez in his first letter to the Emperor Charles the V., "that in the province of "Malinaltebeque, there was gold in abundance, "I engaged the Lord Montezuma to esta- "blish there a farm for your Majesty. He "went to work with so much zeal, that in

* 1,900,152*l.* sterling. *Trans.*

" less than two months, sixty fanegas of maize " and ten of beans were already sown. Two " thousand cacap trees (cocoa) were also plant- " ed, yielding a fruit similar to the almond, " which is sold after being ground. This " fruit is in such estimation, that throughout " all the country it is used as money, and " employed in purchases in the markets and " every where else *." The cocoa is still made use of as a sort of inferior coin in Mexico; and as the smallest coin of the Spanish Colonies is a demi-real (*un medio*) equal to twelve sous, the common people find the employment of cocoa as a circulating medium, extremely convenient. A sou is represented by six grains.

The use of *vanilla* passed from the Aztecs to the Spaniards. The Mexican chocolate, as we have already observed, was perfumed with several aromatics, among which the pod of the vanilla occupied the first place. At this day the Spaniards deal in this precious production, for the purpose of selling it to the other European nations. The Spanish chocholate contains no vanilla; and there is even a prejudice at Mexico, that this perfume is hurtful to the health, especially to those whose nervous system is very irritable. They say quite gravely that the vanilla occasions nervous disorders (*la baynilla da pasmo*). A few years ago the same thing was said of the use of coffee, which begins however to spread among the natives.

* *Lorenzana*, p. 91. § 26. *Clavigero*, i. p. 4; ii. p. 209; iv. p. 207.

When we consider the excessive price at which the vanilla has constantly been sold in Europe, we are astonished at the negligence of the inhabitants of Spanish America, who neglect the cultivation of a plant, which nature spontaneously produces between the tropics, almost wherever there is heat, shade, and much humidity. All the vanilla consumed in Europe comes from Mexico, by the way of Vera Cruz alone. It is produced on an extent of ground of a few square leagues. There is not a doubt, however, that the coast of Caracas, and even the Havannah, might carry on a very considerable trade. We found in the course of our herborizations very aromatic pods of vanilla, exceedingly aromatic, and of an extraordinary size, in the mountains of Caripe, on the coast of Paria; in the fine valley of Bordones near Cumana; in the environs of Portocabello and Guaiguaza; in the forests of Turbaco near Carthagena; in the province of Jaen, on the banks of the river Amazons; and in Guayana at the foot of the granite rocks, which form the great cataracts of the Orinoco. The inhabitants of Xalapa, who carry on the commerce of the fine Mexican vanilla of

Misantla, were struck with the excellence of that brought by M. Boupland from the Orinoco, gathered by us in the woods which surround the *Raudal de Maypure*. Vanilla plants are to be found in the Island of Cuba, (*Epidendrum Vanilla*) on the coast of Bahia, Honda, and at Mariel. That of St. Domingo has a very long fruit, but is not very odoriferous; for frequently great humidity, while it is favourable to the vegetation, is unfavourable to the developement of the aromatic. However, botanical travellers must not judge of the quality of the vanilla, from the odour which it gives out in the forests of America, for this odour is in a great measure owing to the flower, which in the deep and humid vallies of the Andes, is sometimes four or five centimetres in length.*

The author of the *Philosophical History of the East and West Indies* †, complains of being unable to procure satisfactory information respecting the cultivation of the vanilla in Mexico. He did not even know the districts where it was produced. Having been on the spots, I was able to obtain more accurate and detailed

* From an inch and a half, to 2 inches. *Trans.*

† *Raynal*, t. ii. p. 68. § 16. *Thiery de Menonville, de la Culture du Nopal*, p. 142. A small quantity of vanilla is also cultivated in Jamaica, in the parishes of St. Anne and St. Mary. *Brown*, p. 326.

information; and I consulted at Xalapa and Vera Cruz, persons, who for thirty years have carried on the commerce in vanilla of Misantla, Colipa, and Papantla. The following is the result of my researches as to the actual state of this interesting branch of national industry.

All the vanilla supplied by Mexico to Europe is produced in the two intendancies of Vera Cruz and Oaxaca. This plant principally abounds on the eastern slope of the Cordillera of Anahuac between 19° and 20° of latitude. The natives early perceived, that notwithstanding the abundance, the harvest was very difficult, on account of the vast extent of ground necessary to be gone over annually, and they collected a great number of the plants into a narrower space. This operation did not demand much care; it was merely necessary to clear a little the soil, and to plant two slips of epidendrum at the foot of a tree, or to fix parts cut from the stalk to the trunk of a Liquidambar, an Ocotea, or an arborescent Piper.

The slips are in general from four to five decimetres in length.* They are tied to the trees up which the new stalk must climb. Each slip yields fruit in the third year. They calculate on fifty pods on each, for thirty or forty years, especially if the vegetation of the vanilla is

* About a foot. *Trans.*

not checked by the proximity of other claspers which choke it. The *baynilla cimarona*, or wild vanilla, which has not been planted by the hand of man, and which grows in a soil overgrown with shrubs and climbing plants, bears in Mexico fruit of a very dry nature, and in exceeding small quantity.

In the intendancy of Vera Cruz, the districts celebrated for the vanilla commerce, are the *subdelegacion de Misantla*, with the Indian villages Misantla, Colipa, Yacuatla, (near the Sierra de Chicunquiato) and Nautla, all formerly belonging to the *Alcaldia mayor de la Antigua;* the *jurisdiccion de Papantla*, and those of Santiago and San Andres *Tuxtla*. Misantla is thirty leagues distant from Vera Cruz to the north-west, and twelve leagues from the sea coast. It is a charming place, in which the torment of the *Mosquitos* and the *Gegen*, so numerous in the port of Nautla, on the banks of the Rio de Quilate, and at Colipa, is quite unknown. If the river of Misantla, the mouth of which is near the Barra de Palmas, were rendered navigable, this district would soon reach a high degree of prosperity.

The natives of Misantla, collect the vanilla in the mountains and forests of Quilate. The plant is in flower in the months of February and March. The harvest is bad, if at this period the north winds are frequent and accompanied with much rain. The flower drops without yielding fruit, if the humidity is too great. An extreme drought is equally hurtful to the growth of the plant. However, no insect attacks the green fruit on account of the milk it contains. They begin to cut it in the months of March and April, after the sub-delegate has proclaimed that the harvest is permitted to the Indians: it continues to the end of June. The natives, who remain eight successive days in the forests of Quilate, sell the vanilla fresh and yellow to the *gente de razon*, i. e. the whites, mestizoes and mulattos, who alone know the *beneficio de la baynilla*, namely, the manner of drying it with care, giving it a silvery lustre, and sorting it for transportation into Europe. The yellow fruits are spread out on cloths, and kept exposed to the sun for several hours. When sufficiently heated, they are wrapped up in woollen cloths for evaporation, when the vanilla blackens, and they conclude with exposing it to be dried from the morning to the evening in the heat of the sun.

The method of preparing the vanilla at Colipa, is much superior to the *beneficio* employed at Misantla. It is asserted, that on unpacking the vanilla at Cadiz, not more than six per cent. is found to be damaged in that of Colipa; while in that of Misantla, the quan-

tity of rotten or damaged pods amounts to at least the double. This last variety is more difficult to dry, because its fruit is larger and more aqueous than that of Colipa, which is produced in savannahs, and not in the mountains, and is called *baynilla de acaguales*. When the rainy season does not permit the inhabitants of Misantla and Colipa to expose the vanilla to the rays of the sun, they are obliged to recur to an artificial heat, till it have acquired a blackish colour, and is covered with silvery spots (*manchas plateadas*). They form, by means of small reeds, a frame, which they suspend by cords, and cover with woollen cloth, and on which they spread the pods. The fire is placed below, but at a considerable distance. The pods are dried by agitating slightly the frame, and gradually heating the reeds and the cloth. Much care, and long experience, is necessary to succeed in drying sufficiently the vanilla in this way, which is called *beneficio de poscoyol*. The loss is generally very great when artificial heat is employed.

At Misantla, the fruits of the vanilla are collected into packets, called *mazos:* a mazo contains 50 pods, consequently a thousand (*millar*) twenty *mazos*. Although the whole of the vanilla which enters into commerce appears to be the produce of a single species of epidendrum (*Tlilxochitl*,) yet the fruit is

nevertheless divided into four different classes. The nature of the soil, the humidity of the air, and the heat of the sun, have all a singular influence on the size of the pod, and the quantity of oily and aromatic parts contained in it. The four classes of vanilla are the following, beginning with those of a superior quality: *baynilla fina*, in which the *grande fina* and the *chica fina* or *mancuerna* are again distinguished; the *zacate;* the *rezacate*, and the *basura*. Each class is easily recognized in Spain from the manner in which the pacquets are made up. The *grande fina* is in general 22 centimetres in length*, and each *mazo* weighs, at Misantla, ten ounces and a half, and at Colipa, from nine to ten ounces. The *chica fina* is five centimetres shorter than the former, and is purchased one half cheaper. The *zacate* is a very long vanilla, extremely slender, and very acqueous. The *basura*, of which a pacquet contains a hundred pods, serves only to fill the bottom of the packages sent to Cadiz. The worst quality of the Misantla vanilla is called *baynilla cimarona* (wild) or *baynilla palo;* it is very slender and almost destitute of juice. A sixth variety, the *baynilla pompona* has a very large and beautiful fruit. It has been several times sent to Europe, and by means of the Genoese merchants into

* 8½ inches. *Trans.*

the Levant; but as its odour is different from the vanilla called *grande fina* it has never hitherto had any sale.

We see from what has been stated respecting the vanilla, that it is with the goodness of this commodity as with that of the quinquina, which not only depends on the species of cinchona from which it proceeds, but also on the height of the country, the exposure of the tree, the period of the harvest, and the care employed in drying the bark. The commerce of both the vanilla and quinquina is in the hands of a few persons called *habilitadores*, because they advance money to the *cosecheros*, i. e. to the Indians employed in the harvest, who are in this way under the direction of undertakers. The latter draw almost the whole profit of this branch of Mexican industry. The competition among the purchasers, is so much less at Misantla and Colipa; as a long experience is necessary to guard against deception in the purchase of prepared vanilla. A single stained pod (*manchada*) may occasion the loss of a whole chest, in the passage from America to Europe. The blemishes which are thus discovered either in the pod or the stalk (*garganta*) are designated by particular names (*mojo negro, mojo blanco, garro.*) A prudent purchaser examines over and over the pacquets which he sends in the same chest.

The *habilitadores* have purchased, for the last twelve years, the thousand of vanilla of the first class at an average price of 25 or 35 piastres; the thousand of *zacate* at ten, and of *rezacate* at four piastres. In 1803, the price of the *grande fina* was 50, and the *zacate* 15 piastres. The purchasers, far from paying the Indians in ready money, supply them in barter, and at a very high price, with brandy, cocoa, wine, and more especially with cotton cloth, manufactured at Puebla. In this barter consists part of the profits of these monopolists.

The district of *Papantla*, formerly an *Alcaldia mayor*, is situated 18 leagues to the north of Misantla; it produces very little vanilla, and that little is, besides, badly dried, though very aromatic. The Indians of Papantla, as well as those of Nautla, are accused of introducing themselves furtively into the forests of Quilate, for the sake of collecting the fruit of the epidendrum, planted by the natives of Misantla. In the intendancy of Oaxaca, the village of *Teutila* is celebrated for the superior quality of the vanilla produced in the neighbouring forests. It appears, that this variety was the first which was introduced into Spain in the sixteenth century; for even at this day, the *baynilla de Teutila* is considered at Cadiz as preferable to every other. It is indeed dried with much care, being pricked with pins, and suspended by

threads of the *Pite ;* but it weighs less by nearly a ninth than that of Misantla. I know not the quantity of vanilla produced in the province of Honduras, and annually exported from the small port of Truxillo ; but it appears to be very inconsiderable.

The forests of Quilate yield, in very abundant years, 800 millares of vanilla; a bad harvest in very rainy years amounts only to 200. The mean produce is estimated thus—

	Millares.
Misantla and Colipa - - - - - - -	700
Papantla - - - - - - - -	100
Teutila - - - - - - - -	110

The value of these 910 millares is, at Vera Cruz, from 30 to 40,000 piastres. We must add the produce of the harvests of Santiago and San Andres Tuxtla, for which I am in want of sufficiently accurate data. It frequently happens that the harvest of one year does not pass all at once into Europe, but that a part of it is reserved to be added to that of the following year. In 1802, 1793 millares of vanilla left the port of Vera Cruz. It is astonishing, that the total consumption of Europe is not greater.

The same eastern slope of the Cordillera, on which the vanilla is produced, produces also the *sarsaparilla* (*zarza*) of which there was exported

from Vera Cruz, in 1803, nearly 250,000 * kilogrammes †, and the *Jalap* (*Purga de Xalapa*) which is the root, not of the mirabilis jalapa, of the M. longiflora, or of the M. dichotoma, but of the *convolvolus jalapa*. This convolvolus vegetates at an absolute height of from 13 to 14 hundred metres ‡ on the whole chain of mountains extending from the Volcan d'Orizaba, to the Cofre de Perote. We did not meet with it in our herborizations around the town of Xalapa itself; bnt the Indians who inhabit the neighbouring villages brought us some excellent roots of it collected near Banderilla, to the east of San Miguel el Soldado. This valuable remedy is procured in the *Subdelegacion de Xalapa*, around the villages of Santiago, Tlachi, Tihuacan de los Reyes, Tlacolula, Xicochimalco, Tatatila, Yxhuacan, and Ayahualulco ; in the *jurisdiccion de San Juan de los Llanos*, near San Pedro Chilchotla and Quimixtlan ; in the *partidos* of the towns of *Cordoba*, *Orizaba*, and *San Andres Tuxtla*. The true *Purga de Xalapa* delights only in a temperate climate, or rather an almost

* 551,750 lb. avoird. *Trans.*

‡ The sarsaparilla employed in commerce proceeds from several species of smilax, very different from the S. Sarsaparilla. See the description of the ten new species, brought by us in the species of M. *Willdenow*. T. iv. p. i. p. 773.

‡ From 4264 to 4592 feet. *Trans.*

cold climate, in shaded valleys, and on the slope of mountains. I was so much the more surprized, therefore, on learning after my return to Europe, that an intelligent traveller who has displayed the greatest zeal for the good of his country, Thiery de Menonville*, had asserted that he found the jalap in great abundance in the arid and sandy tracts in the neighbourhood of the port of Vera Cruz, and consequently under a climate excessively warm, and at the level of the ocean.

Raynal asserts†, that Europe consumes annually 7500 quintals of jalap. This estimate appears too much by one half; for from the most accurate information which I was able to procure at Vera Cruz, there was only exported from that port in 1802, 2921, and in 1803, 2281 quintals of jalap. The price at Xalapa, is from 120 to 150 francs the quintal.

We did not see, during our stay in New Spain, the plant which, it is pretended, yields the *root of Mechoacan*, (the *Tacuache* of the Tarasck Indians, and the *Tlalantlacuitlapilli* of the Aztecs.) We never, even during the course

* *Thiery*, p. 59. This jalap of Vera Cruz, appears to be the same with that found by Mr. Michaux, in Florida. See the Memoir of Mr. Desfontaines, on the Convolvulus Jalapa, in the *Annales du Museum d'Histoire Naturelle*. t. ii. p. 120.

† *Hist. Philos.* t. ii. p. 68.

of our travels in the antient kingdom of Michoacan, which is part of the intendancy of Valladolid, heard any mention made of it. The abbe Clavigero* relates, that a physician of the late king of Tzintzontzan, communicated the knowledge of this remedy to the religious missionaries of the expedition of Cortez. Does there really exist a root, which under the name of *Mechoacan*, is exported from Vera Cruz, or does this remedy, which is the same as the *jeticucu* of Marcgrave†, come from the coast of Brazil? It appears even, that antiently, the true jalap was called *Mechoacan*, and that by one of those mistakes so frequent in the history of medicines, the denomination has been afterwards transferred to the root of another plant.

The cultivation of Mexican *tobacco*, might become a branch of agriculture of the very highest importance, if the trade in it were free; but since the introduction of the monopoly, or since the establishment of the *royal farm*, (*el estanco real de Tabaco*) by the *Visitador* Don Joseph de Galvez, in 1764, not only a special permission is necessary to plant tobacco, and the cultivator obliged to sell it to the *farm*, at a price arbitrarily fixed according to the worth

* *Storia antica di Messico*, t. ii. p. 212.

† *Linn. Mat. Medica*, 1749, p. 28. *Murray Apparatus medicaminum*, t. i. p. 62.

sons in easy circumstances used tobacco alone; for we see at this day, that the use is entirely unknown to the Indians of pure extraction, because they almost all descend from the lowest class of the Aztec nation.*

At Vera Cruz, the quantity of tobacco produced in the districts of Orizaba and Cordova, is estimated at eight or ten thousand *tereios*, (at 8 arrobas) equal to 1,600,000, or 2,000,000 of pounds; but this estimate appears to be a great deal too low. The king pays for the pound of tobacco to the cultivator $2\frac{1}{2}$ reals, that is to say, 21 sous for the kilogramme. We shall see in the sequel of this work, and from data which I extracted from official papers, that the farm of Mexico of tobacco and snuff, is annually sold in the country even for more than 38 millions of francs†, and that it yields to the king a net profit of more than 20 millions of livres tournois.‡ This consumption of tobacco in New Spain, must appear enormous, especially when we consider, that from a population of 5,800,000 souls, we must deduct two millions and a half of Indians who never smoke. In Mexico, the farm is an object of much greater importance to the public revenue than in

* See vol. i. ch. vi. p. 155.

† 1,583,460*l.* sterling. *Trans.*

‡ 833,400*l.* sterling. *Trans.*

Peru, because in the former, the number of whites is greater; and the custom of smoking cegars is much more general, and is even practised by women and children. In France, where, according to the researches of Mr. Fabre de l'Aude, there are eight millions of inhabitants who use tobacco, the total consumption is more than forty millions of pounds; but the value of the foreign tobacco imported only amounted, in 1787, to 14,142,000 livres tournois.*

New Spain, far from exporting its own tobacco, draws annually nearly 56,000 pounds from the Havannah. The vexations which the planters experience, added to the preference given to the cultivation of coffee, have, however, much diminished the produce of the farm at Cuba. At this day, that island scarcely supplies 150,000 *arrobas;* whereas before 1794, in good years, the crop was estimated at 315,000 *arrobas,* (7,875,000 pounds†) of which 160,000 arrobas were consumed in the island, and 128,000 sent to Spain. This branch of colonial industry, is of the very greatest importance, even in its actual state of monopoly

* *Peuchet,* p. 315 and 409.

† *Raynal,* (t. iii. p. 268.) only estimated the produce at 4,675,000 pounds. Virginia produced annually, before 1775, more than 55,000 *hogsheads,* or 35 millions of pounds of tobacco. *Jefferson,* p. 323.

and constraint. *La renta de tabaco* of the peninsula, yields a net revenue of six millions of piastres, a revenue arising in a great measure from the sale of the tobacco of the island of Cuba sent to Seville. The magazines of this city sometimes contain stores of 18 or 19 millions of pounds of snuff, the value of which amounts to the exorbitant sum of 200 millions of livres.*

The cultivation of *indigo*, which is very general in the kingdom of Guatimala, and in the province of Caracas, is very much neglected in Mexico. The plantations along the western coast are not even sufficient for the few manufactures of home cotton cloth. Indigo is annually imported from the kingdom of Guatimala, where the total produce of the plantations amounts to the value of 12 millions of livres. This substance, as to which Mr. Beckman has made such learned researches, was known to the Greeks and Romans under the name of *indicum*. The word *anil*, which has passed into the Spanish language, is derived from the Arabian word *niz* or *nil*. Hernandez, speaking of the Mexican indigo, calls it *aniz*. The Greeks, in the time of Dioscorides, drew indigo from Gedrozia; and in the 13th century, Marco Polo carefully described the mode of its preparation in Hindostan. Raynal is wrong

* 8,334,000*l*. sterling. *Trans.*

when he maintains that the Europeans introduced the cultivation of that valuable plant into America. Several species of *indigofera* are peculiar to the New Continent. Ferdinand Columbus, in the life of his father, mentions indigo among the productions of the island of Hayti. Hernandez describes the process by which the natives of Mexico separated the fecula from the juice of the plant, a process different from that now employed. The small cakes of indigo, dried by fire, were called *mohuitli* or *tleuohuilli*. The plant was even designated by the name *Xiuhquilipitzahuac*. Hernandez* proposed to the court, to introduce the cultivation of indigo into the southern part of Spain. I know not if his counsel was followed, but it is certain that indigo was very common in Malta, till towards the end of the 17th century. The species of *indigofera*, from which indigo is at this day procured in the colonies, are: The indigofera tinctoria, I. anil, I. disperma, and I. argentea, as is proved by the most antient hieroglyphical paintings of the Mexicans; even thirty years after the conquest, the Spaniards, who had not yet found out the materials for making ink, wrote with indigo, as is proved

* *Hernandez*, lib. iv. c. 12. p. 108. *Clavigero*, ii. 189. *Beckmann*, l. c. iv. 474-532. *Berthollet, Elemens de l'Art de la Teinture*, ii. 37.

by the papers preserved in the archives of the Duke de Monteleone, who is the last descendant of the family of Cortez. At Santa Fe, they still write with a juice extracted from the fruits of the Uvilla (*Cestrum Tinctorium*), and there exists an order of the court, prohibiting the viceroys from using, in their official papers, any other materials than this blue of the Uvilla, because it had been found that it was more indestructible than the best European ink.

After carefully examining those vegetables which are of importance to the agriculture and commerce of Mexico, it remains for us to give a rapid view of the *productions of the animal kingdom.* Although one of these productions in the greatest request, cochineal, belongs originally to New Spain, it is certain, however, that the most interesting productions for the prosperity of the inhabitants have been introduced there from the antient continent. The Mexicans had not endeavoured to reduce to a domestic state the two species of wild oxen, (*Bos Americanus and Bos Moschatus*) which wander in herds over the plains in the neighbourhood of the *Rio del Norte.* They were unacquainted with the Llama, which in the Cordillera of the Andes is not found beyond the limits of the Southern Hemisphere. They made no use of the wild

sheep of California *, nor of the goats of the mountains of Monterey. Among the numerous varieties of dogs † peculiar to Mexico, one alone, the *Techichi* served for food to the inhabitants. Undoubtedly the want of domestic animals was less felt before the conquest, when every family cultivated but a small extent of ground, and when a great part of the inhabitants lived almost exclusively on vegetables. However the want of these animals compelled a numerous class of the inhabitants, the *Tlamama*, to labour as beasts of burden, and to pass their lives on the highways. They were loaded with large leathern chests (in Mexican *Petlacalli*, in Spanish *petacas*) which contained goods to the weight of 30 or 40 kilogrammes. ‡

Since the middle of the sixteenth century, the most useful animals of the old continent, oxen, horses, sheep, and hogs, have

* As to the wild sheep and goats of the mountains of Old and New California, see vol. ii. chap. viii. p. 327.

† See my *Tableaux de la Nature*, t. i. p. 124—127. The Cumanchis, a tribe of the northern provinces, employ dogs in the carriage of tents, like many of the tribes of Siberia. See vol. ii. p. 286. The Peruvians of Sausa (Xauxa) and Huanca ate their dogs (*runalco*), and the Aztecs sold in their markets the flesh of the mute dog *techichi*, which was castrated for the purpose of fattening. *Lorenzana*, p. 103.

‡ From 66 to 88 lb. avoird. *Trans.*

multiplied surprisingly in all the parts of New Spain, and especially in the vast plains of the *Provincias Internas*. It would be superfluous to refute here * the rash assertion of M. de Buffon, as to the pretended degeneracy of the domestic animals introduced into the New Continent. These ideas were easily propagated, because, while they flattered the vanity of Europeans, they were also connected with brilliant hypotheses, relative to the ancient state of our planet. When facts are carefully examined, naturalists perceive nothing but harmony where this eloquent writer announced discordancy.

There is a great abundance of horned cattle all along the eastern coast of Mexico, especially at the mouths of the rivers of Alvarado, Guasacualco, and Panuco, where numerous flocks feed on pastures of perpetual green. However, the capital of Mexico, and the great cities adjoining, draw their animal food from the intendancy of Durango. The natives, like the greatest part of the Asiatic tribes to the east of the Ganges †, care very

* This refutation is to be found in the excellent work of *Mr. Jefferson on Virginia*, p. 109. 166. See also *Clavigero*, t. iv. p. 105. 160.

† For example, in the South-east of Asia, the Chinese, and the inhabitants of Cochinchina. The latter never milk their cows, though the milk is excellent under the Tropics, and in the warmest regions of the earth. Travels of

little for milk, butter and cheese. The latter is in great request among the Casts of mixed extraction, and forms a very considerable branch of exterior commerce. In the statistical table drawn up by the Intendant of Guadalaxara, in 1802, which I have frequently had occasion to cite, the annual value of dressed hides is estimated at 419,000 piastres, and that of tallow and soap at 549,000 piastres. The town of Puebla alone manufactures annually 200,000 *arrobas* of soap, and 82,000 ox hides; but the exportation of these articles at the port of Vera Cruz has hitherto been of very little importance. In 1803, it hardly amounted to the value of 140,000 piastres.

It appears that even in the 16th century, before the interior consumption had been augmented by the number and the luxury of the whites, New Spain supplied Europe with more hides than at the present day. Father Acosta *, relates that a fleet which entered Seville in 1587, carried 64,340 Mexican hides. The horses of the northern provinces, and particularly those of New Mexico, are as celebrated for their excellent qualities as the horses of Chili;

Macartney, vol. ii. p. 153. and vol. iv. p. 59. The Greeks and Romans even only learned to make butter from their communication with the Scythians, Thracians, and the Germanic nations. Beckmann. l. c. b. iii. p. 289.

* Lib. iv. c. 3.

both descend, as it is pretended, from the Arab race; and they wander wild in herds, in the Savannahs of the *Provincias Internas*. The exportation of these horses to Natchez and New Orleans, becomes every year of greater importance. Many Mexican families possess in their *Hatos de ganado*, from thirty to forty thousand head of horses and oxen. The mules would be still more numerous, if so many of them did not perish on the highways from the excessive fatigues of journeys of several months. It is reckoned that the commerce of Vera Cruz alone, employs annually nearly 70,000 mules. More than 5000 are employed as an object of luxury in the carriages * of the city of Mexico.

The rearing of *sheep* has been wonderfully neglected in New Spain, as well as in all the Spanish Colonies of America. It is probable that the first sheep introduced in the 16th century, were not of the breed of travelling *Merinos*, and particularly that they were not of the Leon, Segovian, or Sorian breed. Since that time, no care has been employed in the amelioration of the breed; and yet in the part of Mexico, beyond the tropics, it would be easy to introduce the system of management known in Spain by the name of *Mesta*, by which the sheep change their climate with the seasons, and are always in harmony with them. Nothing is to be feared for ages from the prejudice which these travelling flocks might occasion to Mexican agriculture. At present the finest wool is reckoned to be that of the Intendancy of Valladolid.

* Havannah has 2500 Calashes, called *Volantes*, which require more than 3000 mules. In 1802, the number of horses in Paris was calculated at 35,000.

It is worthy of remark, that neither the common hog*, nor the hens to be found in all the islands of the South Sea, were known to the Mexicans. The Picari (*Sus tajassu*) to be frequently met with in the cottages of the natives of South America, might have easily been reduced to a domestic state; but this animal is only fit for the region of plains. Of the two varieties of hog which are now the most common in Mexico, the one was in-

* Pedro de Cieça, and Garcilasso de la Vega, have preserved in their works the names of the Colonists who first reared in America the domestic animals of Europe. They relate that in the middle of the 16th century, two hogs cost at Peru 8000 livres, a camel 35,000, an ass 7700, a cow 1200, and a sheep 200 livres. *Cieça Chronica del Peru* (Antwerp 1554) p. 65. *Garcilasso*, t. i. p. 328. These enormous prices, besides proving the scarcity of the objects sold, prove also the abundance of the precious metals. General Belcalazar, who had purchased at Buza a sow for 4000 francs, could not resist the temptation of eating her at a feast. Such was the luxury which prevailed in the army of the *Conquistadores*.

troduced from Europe, and the other from the Philippine Islands. They have multiplied amazingly on the Central Table Land, where the valley of Toluca carries on a very lucrative trade in bacon.

Before the conquest there were very few poultry among the natives of the new continent. The maintenance of these birds require particular care in countries recently cleared, where the forests abound in carnivorous quadrupeds of every kind. Besides, the inhabitant of the Tropics does not feel the want of domestic animals so much as the inhabitant of the temperate zone, because he is freed by the fertility of the soil from the necessity of labouring a great extent of ground, and because the lakes and rivers are covered with an innumerable quantity of birds, easily caught, and yielding an abundant nourishment. A European traveller is astonished to see the savages of South America bestowing extreme pains in taming monkeys, *Manaviri* (*Ursus caudivolvula*) or squirrels, while they never endeavour to tame a great number of useful animals, contained in the neighbouring forests. However, the most civilized tribes of the new continent reared in their stable-yards, before the arrival of the Spaniards, several gallinaceous birds, as hoccos, (Crax nigra, C. globicera,

and C. pauxi) turkies, (meleagris gallo-pavo) several species of pheasants, ducks, and moorhens, yacous, or guans, (penelope, *pava de monte*) and aras, (psittacci macrouri) which are considered delicate eating when young. At this period, the cock, a native of the East Indies, and common to the Sandwich Islands, was totally unknown in America. This fact, important in its connection with the migration of the Malay tribes, has been contested in Spain since the end of the 16th century. Learned Etymologists proved that the Peruvians must have had hens previous to the discovery of the New World, because the language of the Incas designates the cock by a particular word, *gualpa*. They knew not that *gualpa* or *huallpa*, is a contraction of *Atahuallpa*, and that the natives of Cuzco gave in derision the name of a prince, detested on account of the cruelties exercised by him against the family of Huescar, to the cocks brought by the Spaniards, imagining, which appears strange enough to the ears of a European, they found some resemblance between the crowing of that bird and the name of Atahuallpa. This anecdote, to be found in the work of *Garcilasso*, (t. i. p. 331.) was related to me in 1802, at Caxamarca, where I saw, in the family of the *Astorpilco*, the descendants of the last Inca of Peru.

These poor Indians inhabit the ruins of the palace of Atahuallpa. Garcilasso relates, that the Indians imitated the crowing of the cock, by pronouncing in cadence words *of four syllables*. The partisans of Huescar had composed burlesque songs in derision of Atahuallpa, and three of his generals, named Quilliscacha, Chalchuchina, and Ruminavi. When we consult languages as historical monuments, we must carefully distinguish what is ancient from what has been naturalized by custom. The Peruvian word for a cat, *micitu*, is as modern as *huallpa*. The Peruvians formed *micitu* from the radical *miz*, because they observed that the Spaniards made use of it in calling the cat, and they believed, therefore, *miz* to be the name of the animal.

It is a very singular phisiological phenomenon, that on the Table Land of the city of Cuzco, more elevated and colder than that of Mexico, hens have only begun to season to the climate, and to propagate, within the last thirty years. Till that period, all the chickens perished immediately after hatching. At present, the different varieties of hens, especially those of Mosambique, of which the flesh is black, have become common in both hemispheres, wherever the people of the old continent have penetrated. Several tribes of Savage Indians, who live in the vicinity of European

settlements have procured them. When we were at Tomependa, on the banks of the river Amazons, we saw several families of Xibaros Indians, who had established themselves at Tatumbero in an almost inaccessible place between the cataracts of Yaraquisa and Patorumi; and several hens were seen in the huts of these savages, when they were visited, for the first time, some years ago.

New Spain has supplied Europe with the largest and most useful of domestic gallinaceous birds, the *turkey* (*totolin* or *huexolotl*) which was formerly found wild on the back of the Cordilleras, from the Isthmus of Panama to New England. Cortez relates that several thousands of these birds which he calls hens (*gallinas*) were fed in the poultry-yards of the castles of Montezuma. From Mexico the Spaniards carried them to Peru, to Terra Firma, (*Castilla del Oro*) and the West India Islands, where Oviedo described them in 1515. Hernandez even then very well observed that the wild turkies of Mexico were much larger than the domestic ones. The former are only now to be found in the northern provinces. They withdraw towards the north in proportion as the population increases, and consequently, the forests become more rare. An intelligent traveller, to whom we owe a very interesting description of the countries to the west of the

Alleghany mountains*, M. Michaux, informs us that the wild turkey of Kentucky sometimes weighs even 40 pounds; an enormous weight for a bird which flies so rapidly, especially when pursued. When the English, in 1584, landed in Virginia, turkies had for fifty years been introduced into Spain, Italy, and England.† This bird did not then pass from the United States into Europe, as has been falsely maintained by many naturalists.

The *Pintades* (*numida meleagris*) designated so happily by the ancients under the name of *aves guttatæ*, are very rare in Mexico, while they have grown wild in the Island of Cuba. As to the *musk-duck* (*anas moschata*) called by the Germans, Turkish duck, which has become so common in our poultry-yards, Europe is indebted for it also to the New Continent. We found it wild on the banks of the river Madelena, where the male grows to a prodigious size. The ancient Mexicans had tame ducks which they annually plucked, as the feathers were an important object of commerce. These ducks appear to have been crossed with the species introduced into Europe. The goose is the only one of the birds of our poultry-yards which is no where to be found in the Spanish Colonies of the New Continent.

* Voyage de Michaux, p. 190.

† Beckmann, l. c. t. iii. p. 238—270.

The cultivation of the mulberry, and the rearing of *silk-worms*, were introduced by the care of Cortez, a few years after the siege of Tenochtitlan. There is a mulberry tree on the ridge of the Cordilleras peculiar to the equinoctial regions, the *morus acuminata*, Bonpl. which we found wild in the kingdom of Quito, near the villages of Piso and Puembo. The leaf of this mulberry is not so hard as that of the red mulberry, (*M. rubra*) of the United States, and the silk-worms eat it like that of the white mulberry of China. This last tree, which, according to Olivier de Serres, was only planted in France, in the reign of Charles the Eighth, about the year 1494, was already very common in Mexico, about the middle of the 16th century. A considerable quantity of silk was then produced in the Intendancy of la Puebla, in the environs of Panuco*, and in the Province of Oaxaca, where several villages of the *Misteca* still bear the names of *Tepexe de la Seda* (Silk), and *San Francisco de la Seda*. The policy of the Council of the Indies, constantly unfavourable to the manufactures of Mexico, on the one hand, and on the other, the most active commerce with China, and the interest which the Philippine Company have in selling the Asiatic silks to the Mexicans, seem to be the principal causes of the gradual annihilation of this

* *La Florida del Inca* (Madrid, 1723) t. i. p. 258.

branch of colonial industry. A few years ago, an individual at Queretaro, proposed to the government the making of large plantations of mulberry, in one of the finest valleys of Mexico *la Cañada* of the baths of San Pedro, inhabited by more than three thousand Indians. The rearing of silk-worms requires less care than cochineal, and the character of the natives renders them extremely fit for every sort of labour, which requires great patience and minute care. The *Cañada*, which is two leagues from Queretaro, towards the north-east, constantly enjoys a mild and temperate climate. The *Lavrus persea* is only now cultivated there, and the viceroys, who dread to infringe on what is called, in the colonies, the rights of the Mother Country, have been unwilling to admit the substitution of mulberries to the present species of cultivation.

New Spain has several species of indigenous caterpillars, which spin silk in the manner of the *Bombyx Mori* of China, but which have never yet been sufficiently examined by entomologists. The silk of the Misteca, derived from these animals, was an object of commerce even in the time of Montezuma. Handkerchiefs are still manufactured in the intendancy of Oaxaca of this Mexican silk. We purchased some on the road to Acapulco, at Chilpanzingo. The

stuff feels rough, like certain Indian silks, which are equally the produce of very different silk-worms, from that of the mulberry.

In the provinces of Mechoacan, and in the mountains of Santa Rosa to the north of Guanaxuato, bags of an oval form, resembling the nests of the Orialus (*Troupiales*), and the *Caciques*, are seen suspended from different kinds of trees, and especially the branches of the *Arbutus Madroño*. These bags called *capullos de madroño*, are the work of a great number of caterpillars of the Bombyx de Fabricius kind, who live in society, and spin together. Each *capullo* is from 18 to 20 centimetres in length, by 21 in breadth.* They are of a brilliant whiteness, and formed in beds, which may be separated from one another. The interior beds are the most slender, and of an extraordinary transparency. — The matter of which these large bags is formed resembles Chinese paper: the tissue is so dense that the threads which are pasted transversely over one another, are scarcely perceivable. I found a great number of these *capullos de madroño*, on descending the coffre de Perote towards las Vigas at an absolute height of 3200 metres.† It is possible

* From 7 to 7½ inches, by 8¾ inches. *Trans.*

† 10,498 feet English. *Trans.*

to write on the interior beds without making them undergo any sort of preparation. It is a true natural paper, of which the antient Mexicans knew the use, pasting together several beds, for the formation of a white and glossy pasteboard. We brought by the courier living caterpillars of the bombyx madroño from Santa Rosa to Mexico: they are of an olive colour, approaching to black and covered with hair, and their length is from 25 to 28 millimetres.* We did not see their metamorphosis, but we perceived that notwithstanding the beauty and extraordinary lustre of this madroño silk, it would be almost impossible to employ it to any advantage on account of the difficulty which would be experienced in winding it. As several caterpillars work together, their threads cross and entangle with one another. I have thought proper to enter into these details, because persons more zealous than well informed, have lately turned the attention of the French Government towards the indigenous silk of Mexico.

Wax is an object of the highest importance to a county where much magnificence prevails in the exterior worship. An enormous quantity is consumed in the festivals of the church, both in the capital, and in the chapels of the smallest

* From .98 of an inch, to 1.1 inch. *Trans.*

Indian villages. The hives are extremely productive in the peninsula of Yucatan, especially in the environs of the port of Campeachy, which, in 1803, exported 582 arrobas of wax, for Vera Cruz. They reckon from 6 to 7 hundred hives in one *colmenar*. This wax of Yucatan is the produce of a bee peculiar to the New Continent, which is said to be destitute of a sting, no doubt because the sting is weak and not very sensible. From this circumstance in the Spanish colonies the name of *little angels* (*angelitos*), has been given to the bees described by M. M. Illiger, Jurine, and Latreille, under the name of Melipone and Trigone. I know not if the bee of Campeachy differs from the *Melipona Fasciata*, found by M. Bonpland on the eastern slope of the Cordilleras.* It is certain that the wax of the American bees is more difficult to whiten, than the wax of the domestic bees of Europe. New Spain draws annually nearly 25,000 *arrobas* of wax from the Havannah, the value of which amounts to more than 2 millions of livres Tournois.† A very small part how-

* See the insects collected in the course of our expedition, and described by M. Latreille in our *Recueil d'observations de Zoologie et d'Anatomie Comparée*, t. i.

† 83,340*l.* sterling. *Trans.*

ever of this wax of the island of Cuba, is the produce of the wild *Trigones* which occupy the trunks of the *Cedrela Odorata;* the greatest part is procured from the bee of the north of Europe (*Apis Mellifica,*) the cultivation of which has been very much on the increase since 1772. The island of Cuba exported in 1803, including the contraband, 42.670 *arrobas* of wax. The price of an *arroba* then amounted to 20 or 21 piastres; but the mean price in time of peace is only 15 piastres, or 75 livres Tournois.* In America, the neighbourhood of the sugar plantations is very prejudicial to the bees. These insects are so exceedingly greedy of honey that they drown themselves in the juice of the cane, which puts them into a state of inaction and intoxication when they drink it to excess.

The rearing of the cochineal, (*Grana Nochiztli,*) is of great antiquity in New Spain; and it is probable that it goes beyond the incursions of the Toltec tribes. In the time of the dynasty of Aztec kings, the cochineal was more general than at present. There were *nopaleries* not only in Mixtecapan (la Misteca), and in the province of Huaxyacac (Oaxaca), but also in the intendancy of Puebla, in the

* £3 2 6 sterling. *Trans.*

environs of Cholula and Huejotzingo. The vexations to which the natives were exposed in the beginning of the conquest, and the low price at which the *encomenderos* forced the cultivators to sell the cochineal, occasioned this branch of Indian industry to be every where neglected, excepting in the intendancy of Oaxaca. It is scarcely 40 years since the peninsula of Yucatan still possessed considerable *nopaleries.* In a single night, all the nopals, on which the cochineal lives, were cut down. The Indians pretend that the government took this violent resolution to raise the value of a commodity, of which they wished to secure the exclusive property to the inhabitants of Misteca. On the other hand, the whites maintain that the natives, irritated and discontented with the price fixed by the merchants on the cochineal, came to a general understanding, to destroy at once, both the insect and the nopals.

The quantity of cochineal which the intendancy of Oaxaca furnishes to Europe, may be estimated, *communibus annis,* including the three sorts, *grana, granilla,* and *polvos de grana,* at 4000 *zurrones,* or 32,000 *arrobas,* which, calculating the *arroba* at 75 double piastres, amounts to 2,400,000 piastres, or

12 millions of livres Tournois *. The cochineal exported from Vera Cruz, was

In 1802, 46,964 arrobas, or 3,368,557 p.
1803, 29,610 arrobas, or 2,238,673 p.

But part of one harvest being frequently added to the harvest of the following year, we are not to judge of the progress of the cultivation from the exportation alone. It appears that in general the nopaleries increase very slowly in Misteca. In the intendancy of Guadalaxara there is scarcely 800 *arrobas* of cochineal produced in a year. Raynal † estimates the whole exportation of New Spain at 4000 quintals, an estimate too low by one half. The East Indies have only begun to pour their cochineal into commerce, but the quantity is very inconsiderable. Captain Nelson carried off the insect from Rio Janeiro in 1793, and nopaleries have been established in the environs of Calcutta, Chittagong, and Madras. Much difficulty was experienced in procuring the species of cactus proper for the nourishment of the insect. We know not if this Brasilian cochineal transported to Asia, be the mealy species of Oaxaca, or if it be the cotton cochineal (*grana silvestre*).

* 500,040*l.* sterling. *Trans.*
† T. ii. p. 78.

I shall not here repeat what Thiery de Menonville, and other naturalists after him, have published on the cultivation of the nopal, and the rearing of the valuable insect which is maintained on it. M. Thiery has displayed as much sagacity in his researches, as courage in the execution of his projects. His observations on the cochineal introduced into St. Domingo, are certainly very accurate; but, ignorant of the language of the country, and afraid of exciting suspicion by a display of too great curiosity, he could only collect, during his stay in the intendancy of Oaxaca, a very imperfect knowledge of the Mexican *nopaleries*. I had occasion to observe the wild cochineal in the kingdom of New Granada, Quito, Peru, and in Mexico, though I was not fortunate enough to see the fine cochineal; but having consulted persons who have lived long in the mountains of *Misteca*, and having had at command extracts from several manuscript memoirs, drawn up by order of the Count de Tessa, during my stay at Mexico, by alcaides and ecclesiastics of the bishoprick of Oaxaca, I flatter myself that I shall be able to communicate some useful information, respecting an insect which has become of the very first importance to European manufactures.

Is the *mealy* fine or Mistec cochineal (*gra-*

na fina) specifically different from the cotton or wild cochineal (*grana silvestre*), or is the latter the primitive stock of the former, which consequently would only be the produce of a degeneracy, originating in the care of man? This problem is as difficult to decide as the question, whether the domestic sheep descends from the *ovis ammon*, the dog from the wolf, and the ox from the *aurochs*. Whatever relates to the origin of species, to the hypothesis of a variety become constant, or a form which perpetuates itself, belongs to problems in zoonomy, on which it is wise to avoid pronouncing decisively.

The fine cochineal differs from the wild one, not only in size, but also in being mealy and covered with a white powder, while the wild one is enveloped in a thick cotton, which prevents its rings from being distinguished; but the metamorphoses of the two insects are the same. In those parts of South America where for ages the wild cochineal has been reared, it has never yet lost its down. It is true, that in the nopaleries, established by M. Thiery at St. Domingo, it was thought to be observed, that the insect under the care of man increased in size, and underwent a sensible change in the thickness of its cotton covering; but Mr. Latreille, a learned entomologist, who is inclined to look upon the wild

cochineal, as a different species from the fine one, believes that this diminution of down is merely apparent, and that it must be attributed to the thickness of the body of the insect. The rings on the back of the female being more dilated, the hairs covering this part must appear less close, and consequently clearer. I was informed by several persons who had long lived in the environs of the town of Oaxaca, that sometimes among the small *coccus* recently brought into the world, individuals are observed covered with very long hair. One might be tempted to consider this fact as a proof, that nature when she deviates from her primitive type, returns to it from time to time. In this way the seed of the fragaria monophylla of M. Duchêsne, constantly produces some common strawberries with parted leaves. But we must not forget that the fine cochineal, on leaving the body of the mother, is wrinkled in the back, and covered with twelve silks frequently very long, which disappear when it becomes adult. Those who have not attentively compared the offspring of the fine cochineal, with that of the wild cochineal, are naturally struck with the presence of these hairs. The fine cochineal appears powdery ten days after its birth, when it frees itself from its fringy dress of small silks, whereas the wild cochineal is

more and more covered as it gets older, its down thickens, and the insect resembles a small white flake, at the period which precedes the conjunction of the two sexes.

It is sometimes observed in the nopaleries of Oaxaca, that the winged male of the fine cochineal couples with the female of the wild cochineal. This fact has been cited as an evident proof of the identity of the species; but we commonly see in Europe *coccinelles* couple together, essentially different in their form, shape, and colour. When two species of insects are in the same vicinity, we ought not to be astonished at their coupling together.

Are the fine cochineal, and the plant on which it feeds, both to be found in a wild state in Mexico? M. Thiery thought himself warranted in answering this question in the negative. This naturalist appears to admit, that the insect and the nopal of the plantations of Oaxaca, have been insensibly modified in their form by means of long culture. This supposition, however, appears to me equally gratuitous with that which would pronounce grain, maize, and the banana, to be degenerated plants, or, to take an example from the animal reign, the llama, which is not known in a wild state, to be a variety of the Peruvian sheep, (*vicuna*) of the Upper Andes. The coccus cacti has an infinite number of enemies among

the insects and birds. Wherever the cotton cochineal propagates of itself, it is not to be found in any abundance, from which we may easily conceive that the mealy cochineal must have been still more rare in its native country, because it is much more delicate, and not being covered with down, is more sensible to the cold and humidity of the air. In discussing the question, whether the fine cochineal would propagate without the care of man, the subdelegate of the province of Oaxaca, Ruiz de Montaya*, cites a very remarkable fact in his memoir, "that at seven "leagues distance from the village of Nexapa, "there is a place, where, favoured by parti- "cular circumstances, the most beautiful *grana* "*fina* is to be found, on very high and very "prickly wild nopals, without any pains hav- "ing ever been bestowed in cleaning the "plants, or in renewing the offspring of the "cochineal." Besides, we are not to be astonished that even in a country where this animal is indigenous, it should seldom be found in a wild state, from the time that it began to be in request among the inhabitants, and to be reared in nopaleries. It is probable that the Toultecs, before undertaking so troublesome a species of cultivation, collected the fine cochineal on the nopals,

* *Gazeta de Literatura de Mexico*, 1794, p. 228.

which grew spontaneously on the sides of the mountains of Oaxaca. Gathering the females before laying, the species would soon be destroyed; and to obviate this progressive destruction, and prevent the mixture of the cotton and mealy cochineals on the same cactus, (the former depriving the latter of all nourishment), nopaleries were established by the natives.

The plants on which the two species of cochineal are propagated, are essentially different; and this undoubted fact is one of those which indicate a primitive and specific difference between the *grana fina*, and the *grana silvestre*. Is it probable, if the mealy cochineal was merely a variety of the cotton cochineal, that it would perish on the same cactus which serves for nourishment to the latter, and which botanists designate by the names of cactus opuntia, C. tuna, and C. ficus indica? M. Thiery, in the work already frequently referred to by us*, asserts, that in the plain of *Cul-de Sac* in Saint Domingo, the cotton-cochineal does not live on the cactus tuna, but on the C. pereskia, which he classes among the articulated Indian figs. I am afraid that this naturalist has confounded a variety of opuntia, with the true pereskia, which is a tree with large and thick leaves, and on which I never yet found any cochineal. I look upon

* P. 275—282.

it also as extremely doubtful, that the plant called by Linneus *cactus coccinellifer*, cultivated in Europe, is the nopal on which the Indians of Oaxaca rear the mealy cochineal. M. Decandolle*, who has thrown much light on this subject, appears to be of my opinion; for he cites the *wild nopal* of Thiery de Menonville, as synonymous with the cochineal Indian fig, which is entirely different from that of the plantations. In fact, Linneus gave the name of cactus coccinellifer to the Indian fig, with which several botanical gardens of Europe had received the cotton-cochineal, a species with a purple flower (*Ficus Indica vermiculos proferens* of Plukenet), which grows wild in Jamaica, the island of Cuba, and almost every where in the Spanish Colonies of the Continent. I have shewn this cactus to well-informed persons, who had carefully examined the nopaleries of Oaxaca, and they have uniformly told me that the *nopal* of the plantations is essentially different from it, and that the latter, as is also affirmed by M. Thiery, is never to be found in a wild state. Moreover, the Abbe Clavigero† who lived five years in Misteca, expressly says, that the fruit of the nopal on which the fine cochineal is reared, is small, insipid, and white, while the fruit of the cactus

* *Plantes grasses de M. M. Redouté et Decandolle*, livraison, 24.

† T. i. p. 115.

coccinellifer is red. The celebrated Ulloa advances in his works that the true nopal is without prickles; but he appears to have confounded this plant with an Indian fig, which we have frequently found in the gardens (*conucos*) of the Indians of Mexico and Peru, and which the creoles, on account of its gigantic size, the excellence of its fruits, and the beauty of its articulations, which are of a blueish green, and destitute of prickles, designate by the name of *tuna de Castilla*. This nopal, the most elegant of all the opuntia, is in fact fit for the nourishment of the mealy cochineal, especially after its birth, but it is seldom to be found in the nopaleries of Oaxaca. If according to the opinion of several distinguished naturalists, the *tuna* or *nopal de Castilla*, is but a variety of the ordinary cactus opuntia, originating in cultivation, we must be surprized that the Indian figs cultivated for centuries in our botanical gardens, and those of the nopaleries of New Spain, have never in the same manner lost the prickles, with which the joints are provided.

The Indians, of the intendancy of Oaxaca, do not all follow the same method in rearing the cochineal, which M. Thiery de Menonville saw practised in his rapid passage through San Juan del Re, San Antonio, and Quicatlan. The

Indians of the district of Sola and Zimatlan.* establish their nopaleries on the slope of mountains, or in ravines, two or three leagues distant from their villages. They plant the nopals after cutting and burning the trees which covered the ground. If they continue to clean the ground twice a year, the young plants are in a condition to maintain the cochineal in the third year. For this purpose the proprietor of a nopalery, purchases in the months of April or May, branches or joints of the *tuna de Castilla*, laden with small cochineals, (*semilla*) recently hatched. These branches, destitute of roots, and separated from the trunks, preserve their juice for several months. They are sold for about three francs the hundred, in the market of Oaxaca. The Indians preserve the *semilla* of the cochineal for twenty days in caverns, or in the interior of their huts, and after this period, they expose the young coccus to the open air. The branches to which the insect is attached, are suspended under a shed covered with a straw roof. The growth of the cochineal is so rapid, that even in the months of August and September, we find mothers already big before the young are yet hatched. These mother-cochineals are placed in *nests*, made of a species of tillandsia, called *paxtle*. They are carried in these nests two or

* *Informe de Don Francisco Ibañez de Corvera.* (M. S.)

three leagues from the village, and distributed in the nopaleries, where the young plants receive the *semilla*. The laying of the mother-cochineal lasts from thirteen to fifteen days. If the situation of the plantation is not very elevated, the first harvest may be expected in less than four months. It is observed, that in a climate more cold than temperate, the colour of the cochineal is equally beautiful, but that the harvest is much later. In the plain, the mother-cochineals grow to a greater size, but they meet with more enemies in the innumerable quantity of insects, (*xicaritas*, *perritos*, *aradores*, *agujas*, *armadillos*, *culebritas*,) lizards, rats, and birds, by which they are devoured. Much care is necessary in cleaning the branches of the nopals. The Indian women make use of a squirrel, or stag's tail, for that purpose; they squat down for hours together beside one plant; and notwithstanding the excessive price of the cochineal, it is to be doubted if this cultivation would be profitable, in countries where the time and labour of man might be turned to account. At Sola, where very cold rains occasionally fall, and where it even frequently freezes in the month of January, the natives preserve the young cochineals, by covering the nopals with rush mats. The price of the *semilla* of *grana fina*, which generally does not amount to more than five francs per pound, frequently rises there to 18 and 20.

In several districts of the province of Oaxaca, they have three cochineal harvests in the year, of which the first (that which gives the *semilla*) is not lucrative, because the mother preserves for a very short time the colouring juice, if she dies naturally after having laid. This first harvest furnishes the *grana de pastle* or *nest cochineal;* so called, because the mothers, after laying, are found in the same nests which have been suspended to the nopals. Near the town of Oaxaca, the cochineal is sown in the month of August; but in the districts of Chontale, this operation does not take place till the month of October; and on the coldest table lands not even till the months of November and December.

The cotton or wild cochineal which gets into the nopaleries, and the male of which, according to the observation of Mr. Alzate, is not much smaller than the male of the mealy or fine cochineal, does much injury to the nopals; and accordingly the Indians kill it wherever they find it, though the colour which it yields is very solid and very beautiful. It appears that not only the fruits, but also the green branches of several species of cactus will dye cotton, violet and red, and that the colour of the cochineal is not entirely owing to a process of *animalization* of the vegetable juices in the body of the insect.

They reckon at Nexapa that in good years

one pound of *semilla* of mealy cochineal placed on nopals in the month of October, in the month of January yields a harvest of 12 pounds of mother cochineals, leaving sufficient *semilla* on the plant, that is to say beginning the harvest only when the mothers have already produced the half of their young. This new semilla again produces till the month of May, 36 pounds. At Zimatlan and other villages of Misteca and Xicayan they scarcely reap more than three or four times the quantity of *cochineal sown*. If the south wind, which is very pernicious to the growth of the insect, has not blown long, and the cochineal is not mixed with *tlasole*, that is to say, with the spoils of the winged males, it loses only two thirds of its weight when dried in the sun.

The two kinds of cochineal (the fine and the wild) appear to contain more of the colouring principle in temperate climates, especially in regions where the mean temperature of the air is 18 or 20 centigrade degrees.* As to the wild cochineal, we found it in abundance in the most opposite climates, in the mountains of Riobamba, at 2900 metres † of absolute elevation, and in the plains of the province of Jaen de Bracamoros, under a burning sky, between the villages of Tomependa and Chamaya.

* 64° and 68° of Fahrenh. *Trans.*

† 9513 feet English. *Trans.*

Around the town of Oaxaca, and especially near Ocotlan, there are plantations (*haciendas*) which contain from 50 to 60,000 nopals planted in lines like pites or *magueys de pulque*. The greatest part of the cochineal which is employed in commerce is, however, produced in small nopaleries belonging to Indians of extreme poverty. The nopal is seldom allowed to grow higher than 12 decimetres *, in order that it may be the more easily cleared of the insects which devour the cochineal. The varieties of the cactus, which are roughest and most prickly, are even preferred, because these arms serve to protect the cochineal from flying insects ; and the flower and fruit are carefully cut to prevent these insects from depositing their eggs in them.

The Indians, who cultivate the cochineal, and who go by the name of *nopaleros*, especially those who live round the town of Oaxaca, follow a very ancient and a very extraordinary practice, that of *making the cochineal travel*. In that part of the torrid zone, it rains in the plains and vallies from May to October, while in the chain of neighbouring mountains called *Sierra de Istepeje*, the rains are only frequent from December to April. In place of preserving the insect in the rainy season in the interior of their huts, the Indians place the mother-

47 inches. *Trans.*

cochineals, covered with palm-leaves by beds in baskets made of very flexible claspers. These baskets (*canastos*) are carried by the Indians on their backs as quickly as possible to the mountains of Istepeje, above the village of Santa Catalina, at nine leagues distance from Oaxaca. The mother cochineals produce their young by the way. On opening the *canastos* they are found full of young *coccus*, which are distributed on the nopals of the *sierra*. They remain there till the month of October, when the rains cease in the lower regions. The Indians then return to the mountains in quest of the cochineal, for the purpose of replacing it in the nopaleries of Oaxaca. The Mexican, in this way, withdraws the insects from the pernicious effects of the humidity, in the same manner as the Spaniard travels with his merinos from the cold.

At the period of the harvests, the Indians kill the mother-cochineals, which are collected on a wooden plate, called *chilcalpetl*, by throwing them into boiling water, or heaping them up by beds in the sun, or placing them on mats in the same ovens of a circular form (*temazcalli*) which are used for vapour and hot air baths of which we have already spoken.* The last of

* See vol. ii. p. 349. M. Alzate who has given a good plate of the temazcalli (*Gazeta de Literatura de Mexico*, t. iii. p. 252.) asserts that the ordinary heat of the vapour in which the Mexican Indian bathes himself, is 66° centigrade. (150° of Fahrenh. *Trans.*)

these methods, which is least in use, preserves the whitish powder on the body of the insect, which raises its price at Vera Cruz and Cadiz. Purchasers prefer the white cochineal, because it is less subject to be fraudulently mixed with parcels of gum, wood, maize, and red earth. There exist, in Mexico, very ancient laws (of the years 1592 and 1594) for the prevention of the falsification of cochineal. Since 1760, they have even been under the necessity of establishing, in the town of Oaxaca, a jury of *veadores*, who examine the bags (*zurrones*) previous to their being sent out of the province. They appoint the cochineal exposed to sale to have the *grain* separated, that the Indians may not introduce extraneous matter in those agglutinated masses, called *bodoques*. But all these means are insufficient for the prevention of fraud. However, that which is practised in Mexico, by the *tiangueros* or *zanganos* (*falcificadores*) is inconsiderable in comparison of that which is practised on this commodity in the ports of the Peninsula, and in the rest of Europe.

To complete the view of the animals of New Spain, we must bestow a rapid glance on the *pearl* and *whale* fisheries. It is probable, that these two branches of fishery will one day become an object of the very highest importance to a country possessed of a length of coast of more than 1700 marine leagues. Long before

the discovery of America, pearls were in great estimation among the natives. Hernando de Soto found an immense quantity in Florida, particularly in the provinces of Ichiaca and Confachiqui, where the tombs of their princes were ornamented with them.* Among the presents made by Montezuma to Cortez, before his entry into Mexico, which were sent by Cortez to the emperor Charles V., there were necklaces set with rubies, emeralds, and pearls. † We know not whether the Aztec kings received any part of these pearls by means of trade with the barbarous and wandering tribes who frequented the gulf of California. It is better ascertained, that pearls were fished by their orders, on the coast which extends from Colima, the northern boundary of their empire, to the province of Xoconochco or Soconusco, and particularly near Tototepec, between Acapulco and the gulf of Tchuantepec and in Cuitlatecapan. The Incas of Peru set a great value on pearls; but the laws of Manco-capa prohibited the Peruvians from exercising the calling of diver, as not very beneficial to the state and dangerous to those who follow it. ‡

The situations, which since the discovery of

* La Florida del Inca, Madrid, 1723, p. 129, 135, and 140.

† Gomara, Conquista de Mexico (Medina del Campo, 1533), fol. 25.

‡ Garcilasso, lib. viii. c. 23.

the New Continent, have furnished the greatest abundance of pearls to the Spaniards, are the following: the arm of the sea between the islands of Cubagua and Coche, and the coast of Cumana; the mouth of the Rio de la Hacha; the gulf of Panama, near the *Islas de las Perlas;* and the eastern coast of California. In 1587, 316 kilogrammes * of pearls were imported into Seville, among which there were 5 kilogrammes † of the greatest beauty, destined for king Phillip II. The pearl fishery of Cubagua and Rio de la Hacha have been very productive, but of short duration. After the commencement of the 17th century, and especially after the navigations of Yturbi and Piñadero, the pearls of California began to rival in trade those of the gulf of Panama. At that period, the most able divers were sent to the shores of the sea of Cortez. The fishery, however, was immediately neglected again; and though at the time of the expedition of Galvez, endeavours were used to restore it, these endeavours were rendered fruitless from the causes already detailed by us in the description of California. ‡ In 1803 only, a Spanish ecclesiastic, residing at Mexico, again turned the attention of govern-

* 697 lb. avoird. *Trans.*

† Acosta, lib. iv. c. 15.

‡ See vol. ii. chap. viii. p. 329.

ment to the pearls of the coast of Ceralvo in California. As the divers (*buzos*) lose much of their time in rising to breathe on the surface of the water, and fatigue themselves to no purpose in descending several times to the bottom of the sea, this ecclesiastic proposed to employ in the pearl fishery, a diving bell, which should serve as a reservoir of atmospheric air, and in which the diver might take refuge whenever he felt the necessity of respiration. Furnished with a mask and a flexible tube he would be enabled to explore the bottom of the ocean, breathing the oxygen supplied by this bell at which the tube terminates. During my residence in New Spain, I saw a series of very curious experiments, made in a small pond, near the castle of Chopoltepec, in the execution of this project. It was certainly the first time that a diver's bell was ever constructed at a height of 2300 metres * equal to that of the *pass* of the Simplon. I know not whether the experiments made in the valley of Mexico were ever repeated in the gulf of California, and whether the pearl fishery has been renewed there after an interruption of more than thirty years; for hitherto almost all the pearls supplied by the colonies come from the gulf of Panama.

* 7545 feet. *Trans.*

Among the marine shells of New Spain, I ought also to mention here the *murex* of the coast of Tehuantepec, in the province of Oaxaca, of which the cloak exudes a purple colouring liquor, and the famous *shell of Monterey*, which resembles the most beautiful haliotis of New Zealand. This *shell* is to be found on the coast of New California, and particularly between the ports of Monterey and San Francisco. It is employed, as we have already observed, in the fur trade with the inhabitants of Noutka. As to the gasteropode of Tehuantepec, the Indian women collect the purple liquor, following the course of the shore, and rubbing the cloak of the murex, with cotton stript of its seed.

The western coast of Mexico, especially that part of the great ocean situated between the gulf of Bayonna, the three Mary islands, and Cape Saint Lucas, abound in *spermaceti-whales* or *cachalots*, of which the fishery is one of the most important objects of mercantile speculation on account of the extremely high prices given for spermaceti (*adipocire*) by the English and the inhabitants of the United States. The Spanish Mexicans see the *cachalot fishers* arrive on their coast, after a navigation of more than 5000 marine leagues, to whom they incorrectly enough give the appellation of balleñeros (*whalers*); but they never endeavour to share in the pursuit of these great *mammiferous whales*. M. Schneider,

who is as good a naturalist, as he is a learned hellenist; and M. M. de Lacepede and Fleurieu * have given very accurate information as to the whale and cachalot fishery in the two hemispheres. I shall here communicate the most recent knowledge which I could collect during my residence on the shores of the South Sea.

Were it not for the cachalot fishery and the trade in furs of sea otters, at Noutka, the great ocean would almost never be frequented by the Anglo-Americans and Europeans. Notwithstanding the extreme economy practised in these fishing expeditions, those beyond Cape Horn are too expensive to admit of the *black whale* being the object of them. The cost of these distant navigations can only be compensated by the high price which necessity or luxury fixes on their returns. Now of all the oily liquids which enter into trade, there are few so dear as the spermaceti, or the particular substance contained in the enormous caverns of the snout of the cachalot. A single individual of these cetaceous giants, yields as much as 125 English *barrels* † (of 32½ gallons each ‡) of

* Voyage de Marchand, t. ii. p. 600, 641.

† A barrel contains 1.48 hectolitres, or nearly 178⅔ pints of Paris (*Recherches sur la Richesse des Nations par Adam Smith*, traduction de M. Garnier, t. v. p. 451.)

‡ This is supposed to be 31½. *Trans.*

spermaceti. A tun, containing eight of these barrels, or 1024 pints of Paris, used to sell in London before the peace of Amiens, at £70 or £80, and during the war at £95 and £100 sterling.

It was not the third expedition of Cook to the north-west coast of the New Continent, but the voyage of James Collnet to the Gallapagos islands, which made known to the Europeans and Anglo-Americans the abundance of cachalots in the great ocean to the north of the equator. Till 1788, the whale fishers only frequented the coasts of Chili and Peru. Only 12 or 15 vessels then doubled Cape Horn annually for the cachalot fishery, while at the period when I was in the South Sea, there were more than 60 under the English flag alone.

The *physeter macrocephalus* not only frequents the arctic seas, between the coast of Greenland and Davis Straits, it is not only found in the Atlantic Ocean between the banks of Newfoundland and the Azore Islands, where the Anglo-Americans sometimes carry on a fishery, but it is also to be found to the south of the equator, on the coasts of Brazil and Guinea. It would appear that in its periodical voyages it approaches more to the continent of Africa than to that of America; for in the environs of Rio Janeiro and la Bahia, whales only are caught. However, the cachalot fishery has been much

diminished on the Guinea coast, since navigators have become less afraid of doubling Cape Horn, and since more attention has been paid to the cetaceous fish abounding in the great ocean. Physeters are found in very considerable bands in the channel of Mosambique, and to the south of the Cape of Good Hope; but the animal there is generally small, and the sea rough and agitated, and unfavourable to the operations of the harpooners.

The great ocean unites all the circumstances that render the cachalot fishery both easy and lucrative. It is richer in molluscus, fish, porpoises, tortoises, and sea calves of every species, and offers more nourishment to cetaceous animals than the Atlantic ocean. Hence, these last are there in greater numbers, as well as fatter and larger. The calm which prevails during so great a part of the year in the equinoctial region of the South Sea, facilitates very much the pursuit of cachalots and whales. The former keep generally near the coasts of Chili, Peru, and Mexico, because the shores are steep (*acantiladas*) and washed by a sea of great depth. It is a general rule, that the cachalot avoids shallows, whereas they are sought after by the whale. For this reason the whale is very frequent on the low coast of Brazil, while the other abounds near the coast of Guinea, which is higher, and every where accessible to large

vessels. Such is in general the geological constitution of the two continents, that the western coast of America and Africa resemble one another, while the eastern and western coasts of the New Continent exhibit the most remarkable contrast in relation to their elevation above the level of the neighbouring seas.

The greatest number of English and Anglo-American vessels which enter the great ocean have the double object in view of carrying on the cachalot fishery, and an illicit commerce with the Spanish colonies. They double Cape Horn after attempting to leave contraband goods at the mouth of the river Plata, or at the *presidio* of the Malouin Islands. They begin the cachalot fishing near the small desert islands of Mocha and Sante Maria, to the south of the Conception of Chili. At Mocha there are wild horses introduced by the inhabitants of the neighbouring coast, which sometimes serve for provisions to navigators. The island of Santa Maria has very fine and very abundant springs. They contain wild hogs, and a species of very large and very nutritive turnips, believed to be peculiar to those climates. After remaining in these latitudes for a month, and carrying on a contraband trade with the island of Chiloe, the fishing vessels (*balleneros*) generally coast Chili and Peru to Cape Blanc, situated in 4° 18′ of south latitude. The cachalot is

every where common in these latitudes, to 15 or 20 leagues distance from the continent. Before the expedition of Captain Collnet, the fishery terminated at Cape Blanc, or near the equator; but within the last 15 or 20 years, the *balleneros* continue it northwards to beyond Cabo Corientes, on the Mexican coast of the intendancy of Guadalaxara. Near the Archipelago of the Galapagos, where it is extremely dangerous to land, on account of the strong currents, and round the islands *de las tres Marias*, the fish is most frequently to be found, and of a gigantic size. In spring, the environs of the Galapagos are the rendezvous of all the macrocephalous cachalots of the coasts of Mexico, Peru, and the gulf of Panama, which come there to couple. During that period M. Collnet saw young individuals of 2 metres in length.* Farther to the north of the *Marias* islands, in the gulf of California, no more physeters are to be found, but many whales.

The whale fishers can easily distinguish, at a distance, the cachalots from the whales, by the manner in which the former spout up the brine through their spiracles. The cachalots can remain longer under water than the true whale. When they come to the surface, their respiration is more frequently interrupted; they do not allow so much water to remain in the membranous bags placed below their nostrils; and the spouts are more frequent, more in a forward direction, and more elevated than those of the other *whales*. The female of the cachalot is four or five times smaller than the male; and its head does not yield more than 25 English barrels of *adipocire*, while the head of the male yields from 100 to 125. A great number of females (*cow-whales*) go generally together led by two or three males (*bull-whales*) which are perpetually describing circles round their flock. The very young females which yield from 12 to 16 barrels of adipocire matter, called by the English fishermen school-whales, swim so close to one another, that they frequently get more than half out of water. It is almost superfluous here to observe that the adipocire, which is not a part of the brain of the animal, is not only to be found in all the known species of cachalot (*catadontes lac.*), but also in all the physales and physeters. The spermaceti extracted from the cavities of the snout of the cachalot, and we must not confound these cavities with that of the cranium, is only the third part of the thick and adipocirous oil, which is furnished by the rest of the body. The spermaceti of the head is the best, and

* 6½ feet. *Trans.*

is employed in the making of candles; and that of the body and tail is only used in England to give a gloss to cloth.

This fishery, to be profitable, must be conducted on the most economical principles. Vessels from 180 to 300 tons are employed in it, and the crew consists only of 16 or 24 individuals, including the captain and master, who are themselves obliged to throw the harpoon, like common sailors. The expenses of equipment of a vessel of 180 tons, lined with copper, and provisioned for a voyage of two years, is estimated in London, at 7000*l.* sterling. Each South-Sea fishing vessel is provided with two canoes. The fitting of each canoe requires 4 sailors and a boy, a steersman, a cable of 130 fathoms in length, 3 lances, 5 harpoons, an axe, and a lantern to make themselves seen at a distance during the night. The fitter out gives the sailors only their food and a very small sum of money under the name of advance. Their pay depends on the produce of the fishery; for as the whole crew contribute to it, every individual has a right to the profit. The captain receives a sixteenth, the master a twenty-fifth, the second master a thirty-fifth, the mate a sixtieth, and the sailor an eighty-fifth of the whole produce. The season is reckoned good, if a vessel of 200 tons, returns to port, laden

with 800 barrels of spermaceti. The cachalot from being so incessantly persecuted, has become within these few years, more wild and difficult to take. But to favour the navigation of the South Sea, the British government allows advances to each vessel fitted out for the cachalot fishery: these advances are from 300*l.* to 800*l.* sterling, according to the tonnage of the vessel. The Anglo-Americans carry on this fishery with still more economy than the English.

The ancient Spanish laws prohibited whale vessels as well as all other foreign vessels from entering the ports of America, except in cases of distress, or want of water and provisions. The Galapagos islands, on which the fishers sometimes land their sick, are provided with springs, but these springs are very poor and very inconstant. The Island of Cocos (Lat. 5° 35′ north) is very well supplied with water; but, in running from the Galapagos northwards, this small insulated island is difficult to find, on account of the force and irregularity of the currents. The whalers have more powerful motives for preferring to take in water from the coast; and they seek pretexts to enter the ports of Coquimbo, Pisco, Tumbez, Payta, Guayaquil, Realejo, Sonzanate, and San Blas. A few days, and frequently even a few hours, are sufficient

for the crews of fishing vessels to form connections with the inhabitants, for the sale of English goods, and to take in ladings of copper, Peruvian sheep, quinquina, sugar, and cocoa. This contraband trade is carried on between persons who do not speak the same language, frequently by signs, and with a fidelity very uncommon among the most polished people of Europe.

It would be superfluous to enumerate the advantages the inhabitants of the Spanish colonies would possess over the English and the people of the United States, if they were to enter upon the cachalot fishery. From Guayaquil and Panama, the parallels, where this fish abounds, is not more than a voyage of ten or twelve days. The navigation from San Blas to the Marias islands is hardly 36 hours. The Spanish Mexicans employed in this fishery would have a shorter passage by 4000 leagues than the Anglo-Americans; they could be supplied with provisions at a cheaper rate; and they would every where find ports where they would be received as friends, and supplied with fresh provisions. It is true, the spermaceti is not yet in great request on the continent of Spanish America. The clergy persist in confounding adipocire with tallow, and the American bishops have declared that the ta-

pers which burn on the altars, can only be made of bee-wax. At Lima, however, they have begun to deceive the vigilance of the bishops, by mixing a little spermaceti with the wax. The merchants purchasing English prizes, had it in great quantities, and the adipocire employed in church festivals is become a new branch of very lucrative commerce.

It is not the want of hands which prevents the inhabitants of Mexico from applying to the cachalot fishery. Two hundred men are sufficient to man ten fishing vessels, and to procure annually more than a thousand tons of spermaceti; and this substance might in time become as important an article of exportation, as the cocoa of Guayaquil, and the copper of Coquimbo. In the present state of the Spanish colonies, the sloth of the inhabitants is inimical to the execution of similar projects; and it would be impossible to procure sailors, willing to embrace so rude a business and so miserable a life, as that of a cachalot fisher. How could they be found in a country, where, according to the ideas of the common people, all that is necessary to happiness, is bananas, salted flesh, a hammock, and a guitar? The hope of gain is too weak a stimulus, under a zone, where

beneficent nature provides to man a thousand means of procuring an easy and peaceful existence without quitting his country, and without struggling with the monsters of the ocean.

For a long time, the Spanish government has looked with an evil eye on the cachalot fishery, which draws the English and Anglo-Americans * to the coast of Peru and Mexico. Before the establishment of that fishery, the inhabitants of the western coast of America had never seen any other flag in those seas than the Spanish. Political reasons might have engaged the mother country to spare nothing for the encouragement of the national fisheries, not so much, perhaps, with a view of a direct profit, as for the sake of excluding strangers, and preventing their connections with the natives. The privileges which they granted to a company residing in Europe, and which has merely existed by name, could not give the first impulse to the Mexicans and Peruvians.

* According to official information, which I owe to M. Gallatin, Treasurer to the United States, there were in the South Sea, in 1800, 1801, and 1802, from 18 to 20 whalers (from 2800 to 3200 tons) of the United States. A third of these vessels are fitted out annually from the port of Nantucket. In 1805, the importation of spermaceti into that port, amounted to 1146 barrels.

The fishing vessels ought to be fitted out in America itself, at Guayaquil, Panama, and San Blas. There is constantly on that coast a certain number of English sailors, who have abandoned the fishing vessels, either through discontent, or for the purpose of pushing their fortunes in the Spanish colonies. The first expedition might be made, by mixing those sailors, who have had long experience in the cachalot fishery, with the *zambos* of America, who are not afraid of singly attacking a crocodile.

We have thus examined, in this chapter, the true national wealth of Mexico; for the produce of the earth is, in fact, the sole basis of permanent opulence. It is consolatory to see that the labour of man for half a century, has been more directed towards this fertile and inexhaustible source, than towards the working of mines, of which the wealth has not so direct an influence on the public prosperity, and merely changes the nominal value of the annual produce of the earth. The territorial impost levied by the clergy, under the name of tenth, or tithe, measures the quantity of that produce, and indicates with precision the progress of agricultural industry; if we compare the periods, in the intervals of

which the price of commodities has undergone no sensible variation. The following is a view of the value of these tithes *; taking for example two series of years, from 1771 to 1780, and from 1780 to 1789:

Names of Dioceses.	Periods.	Value of Tithes in Piastres.	Periods.	Value of Tithes in Piastres.
Mexico - - -	1771—1780	4,132,630	1781—17 90	7,082,879
Puebla de los Angeles - - -	1770—1779	2,965,601	1780—1789	3,508,884
Valladolid de Mechoacan -	1770—1779	2,710,200	1780—1789	3,239,400
Oaxaca - - -	1771—1780	715,974	1781—1790	863,237
Guadalaxara -	1771—1780	1,889,724	1781—1790	2,579,108
Durango - -	1770—1779	913,028	1780—1789	1,080,313

The result of this view is, that the tithes of New Spain have amounted in these six dioceses.

From 1771 to 1779 — to 13,357,157† } Double Piastres,
1779 — 1789 —— 18,353,821‡ } or pezzos fuertes.

* I have extracted this view from a manuscript memoir of M. *Maniao*, drawn up from official papers, and bearing the title of *Estado de la Renta de Real Hacienda de Nueva España, en un año commun del quinquenio de* 1784 *hasta* 1789. The numbers, in this view, differ a little from those published by M. Pinkerton, (vol. iii. p. 234.) from the work of Estalla, which I have never yet been able to procure.

† 2,880,141*l.* sterling. *Trans.*

‡ 4,015,219*l.* sterling. *Trans.*

Consequently the total augmentation has been, in the last ten years, five millions of piastres, or two-fifths of the total produce. The same data also indicate the rapidity of the progress of agriculture, in the intendancies of Mexico, Guadalaxara, Puebla, and Valladolid, compared with the provinces of Oaxaca and New Biscay. The tithes have been nearly doubled in the archbishoprick of Mexico; for those which were levied during the ten years anterior to 1780, were to those levied ten years afterwards, in the proportion of 10 to 17. In the intendancy of Durango or New Biscay, this augmentation has been only in the proportion of 10 to 11.

The celebrated author of the Wealth of Nations *, estimates the territorial produce of Great Britain, from the produce of the land-tax. In the political view of New Spain, which I presented to the court of Madrid in 1803, I had hazarded a similar valuation, from the value of the tithes payable to the clergy. The result of this operation was, that the annual produce of the land amounted at least, to 24 millions of piastres. The results, which I came to in drawing up my first view, have been discussed with much sagacity,

* *Adam Smith*, Traduction de M. Garnier, t. iv. p 264. Original vol. iiij. p. 250.

in a memoir presented by the municipal body of the town of Valladolid de Mechoacan, to the king, in the month of October 1805, on the occasion of passing an edict, relative to the property of the clergy. According to this memoir, a copy of which I have before me, we must add to these 24 millions of piastres, three millions for the produce of cochineal, vanilla, jalap, pimento of Tabasco, sarsaparilla which pay no tithes; and 2 millions for sugar and indigo, which yield only to the clergy a duty of 4 per cent. If we adopt these data, we shall find that the *total agricultural produce* amounts annually to 29 millions of piastres, or to more than 145 millions of francs *, which, reducing them to a *natural measure*, and taking for basis the actual price of wheat in Mexico, 15 francs for 10 myriagrammes of wheat †, are equal to 96 *millions of myriagrammes of wheat.* ‡ The mass of precious metals annually extracted from the mines of the kingdom of New Spain, scarcely represent 74 *millions of myriagrammes of wheat*, which proves the interesting fact, that the value of the gold and silver of the Mexican mines is less, by almost a fourth, than the value of the territorial produce.

* 6,042,150*l.* sterling. *Trans.*

† See vol. ii. p. 481.

‡ 2,128 millions lb. avoird. *Trans.*

The cultivation of the soil, notwithstanding the fetters with which it is every where shackled, has lately made a more considerable progress, on account of the immense capitals laid out in land, by families enriched either by the commerce of Vera Cruz and Acapulco, or by the working of the mines. The Mexican clergy scarcely possess land (*bienes raices*) to the value of two or three millions of piastres; but the capitals which convents, chapters, religious societies, and hospitals have laid out in lands, amount to the sum of 44½ millions of piastres, or more than 222 millions of livres tournois. The following is a view of these capitals, called *capitales de capellanias y obras de la jurisdiccion ordinaria*, extracted from an official paper *:

	Piastres.
Archbishoprick of Mexico - - - -	9,000,000
Bishoprick of Puebla - - - - -	6,500,000
Bishoprick of Valladolid (very accurate valuation)	4,500,000
Bishoprick of Guadalaxara - - - -	3,000,000
Bishopricks of Durango, Monterey, and Sonora	1,000,000
Bishopricks of Oaxaca and Merida - -	2,000,000
Obras Pias of the regular Clergy - - -	2,500,000
Endowments of Churches and Communities of Monks and Nuns	16,000,000
	44,500,000

* *Representacion de los vecinos de Valladolid al Excellentissimo Señor Virreyen fecha del 24 Octubre del año 1805.* (M.S.)

This immense sum in the hands of the land proprietors, (*haciendados*) and hypothecated on real property, was on the point of being withdrawn from the Mexican agriculture in 1804. The ministry of Spain not knowing how a national bankruptcy brought on by the superabundance of paper money (*vales*) could possibly be avoided, ventured upon a very hazardous operation. A royal decree was issued on the 26th December 1804, appointing not only the estates of the Mexican clergy to be sold, but also all the capitals belonging to ecclesiastics, to be recovered and sent into Spain, to be there applied in extinction of the royal paper (*caxa de consolidacion de vales reales*). The council of finance, in which the viceroy presides, and which bears the title of *Junta Superior de Real Hacienda*, instead of opposing this decree, and representing to the Sovereign the injury which its execution would occasion to the agriculture and prosperity of the inhabitants, began boldly to levy the money. The resistance however, was so strong on the part of the proprietors, that, from May 1805 to June 1806, not more than the comparatively small sum of 1,200,000 piastres could be recovered. It is to be hoped that Ministers, well informed as to the true interests of the state, will have since put an end to an operation, the fatal effects of which would have been at last severely felt.

When we read the excellent work on *agrarian laws*, presented to the council of Castille in 1795*, we perceive that notwithstanding the difference of climate and other local circumstances, Mexican agriculture is fettered by the same political causes which have impeded the progress of industry in the Peninsula. All the vices of the feudal government have passed from the one hemisphere to the other; and in Mexico these abuses have been so much the more dangerous in their effects, as it has been more difficult to the supreme authority to remedy the evil, and display its energy at an immense distance. The property of New Spain, like that of Old Spain, is in a great measure in the hands of a few powerful families, who have gradually absorbed the smaller estates. In America, as well as Europe, large commons are condemned to the pasturage of cattle, and to perpetual sterility. As to the clergy and their influence on society, the two continents are not in the same circumstances; for the clergy are much less numerous in Spanish America, than in the Peninsula. The religious missionaries have there contributed to extend the progress of agriculture among barbarous tribes. The introduction

* M. de Laborde has given a translation of this Memoir, in the fourth volume of his *Itineraire descriptif de l'Espagne*, p. 103—294.

of *mayorazgos*, and the degradation and extreme poverty of the Indians, are more prejudicial to industry than the mortmain of the clergy.

The ancient legislature of Castille prohibited convents from possessing real property; and although this wise law has been frequently infringed, the clergy could not acquire very considerable property in a country where devotion does not exercise the same empire over the mind as in Spain, Portugal, and Italy. Since the suppression of the order of the Jesuits, few estates belong to the Mexican clergy; and their real wealth, as we have already stated, consists in tithes and capitals laid out on the farms of small cultivators. These capitals are usefully directed, and increase the productive power of the national labour.

It is surprizing to see that the greatest number of the convents founded since the 16th century in every part of Spanish America, are all crowded together in towns. Had they been spread throughout the country, and placed on the ridges of the Cordilleras, they might have possessed that salutary influence on cultivation, of which the effects have been felt on the North of Europe, on the banks of the Rhine, and on the mountains of the Alps. Those who have studied history, know that in the time of Philip the Second, the monks were no longer like those of the 9th century. The luxury of towns, and

the climate of the Indies are unfavourable to that austerity of life, and that spirit of order for which the first monastical institutions were characterized; and when we cross the mountainous deserts of Mexico, we regret that those solitary asylums in which the traveller receives assistance from religious hospitality in Europe, are no where to be found.

CHAPTER XI.

State of the Mines of New Spain.—Produce of Gold and Silver.—Mean value of the produce of the Mines.—Annual consumption of Mercury in the process of Amalgamation.—Quantity of the Precious Metals which have, since the conquest of Mexico, flowed from the one Continent into the other.

After a careful examination of the Mexican agriculture as the first source of the natural wealth and prosperity of the inhabitants, it remains for us to exhibit a view of the mineral productions which for two centuries and a half have been the object of working the mines of New Spain. This view is exceedingly brilliant to the eyes of those who calculate merely according to the nominal value of things, but is much less so to those who consider the intrinsic worth of the metals, their relative utility, and the influence which they possess on manufacturing industry. The mountains of the New Continent, like the mountains of the old, contain iron, copper, lead, and a great number of other mineral substances, indispensible to agriculture and the arts. If the labour of man has in America been almost exclusively directed to the extraction of gold and silver, it is because the members of a society

act from very different considerations from those which ought to influence the whole society. Wherever the soil can produce both indigo and maize, the former prevails over the latter, although the general interest requires a preference to be given to those vegetables which supply nourishment to man, over those which are merely objects of exchange with strangers. In the same manner, the mines of iron or lead on the ridge of the Cordilleras, notwithstanding their richness, continue to be neglected, because almost the whole attention of the colonists is directed to veins of gold and silver, even when they exhibit on trial but small indications of abundance. Such is the attraction of those precious metals which by a general convention have become the representatives of labour and subsistence.

No doubt the Mexican nation can procure, by means of foreign commerce, all the articles which are supplied to them by their own country; but in the midst of great wealth in gold and silver, want is severely felt whenever the commerce with the mother country, or other parts of Europe or Asia, has suffered any interruption, whenever a war throws obstacles in the way of maritime communication. From 25 to 30 millions of piastres are sometimes heaped up in Mexico, while the manufacturers and miners are suffering from the want of steel, iron, and mercury. A few years before my arrival in

New Spain, the price of iron rose from 20 francs the quintal to 240, and steel from 80 francs to 1300. In those times, when there is a total stagnation of foreign commerce, the Mexican industry is awakened for a time, and they then begin to manufacture steel, and to make use of the iron and mercury of the mountains of America. The nation is then alive to its true interest, and feels that true wealth consists in the abundance of objects of consumption, in that of *things*, and not in the accumulation of the *sign* by which they are represented. During the last war but one between Spain and America, they began to work the iron mines of Tecalitan, near Colima, in the intendancy of Guadalaxara. The *tribunal de mineria* expended more than 150,000 francs in extracting mercury from the veins of San Juan de la Chica; but the effects of so praise-worthy a zeal were only of short duration; and the peace of Amiens put an end to undertakings which promised to give to the labours of miners a more useful direction for the public prosperity. The maritime communication was scarcely well opened, when they again preferred to purchase steel, iron, and mercury in the markets of Europe.

In proportion as the Mexican population shall increase, and from being less dependent on Europe, shall begin to turn their attention to the great variety of useful productions contained in

the bowels of the earth, the system of mining will undergo a change. An enlightened administration will give encouragement to those labors which are directed to the extraction of mineral substances of an *intrinsic value*; individuals will no longer sacrifice their own interests and those of the public to inveterate prejudices; and they will feel that the working of a mine of coal, iron, or lead may become as profitable as that of a vein of silver. In the present state of Mexico, the precious metals occupy almost exclusively the industry of the colonists; and when, in the subsequent part of this chapter, we shall employ the word mine (*real, real de minas*), unless the contrary is expressly stated, a gold or silver mine is to be uniformly understood.

Having been engaged from my earliest youth in the study of mining, and having myself had the direction for several years of subterraneous operations, in a part of Germany which contains a great variety of minerals, I was doubly interested in examining with care the state of the mines and their management in New Spain. I had occasion to visit the celebrated mines of Tasco, Pachuca, and Guanaxuato, in which last place, where the veins exceed in richness all that has hitherto been discovered in other parts of the world, I resided for more than a month; and I had it in my power to compare the different methods of mining practised in Mexico,

with those which I had observed in the former year in Peru; but the immensity of materials collected by me relative to these subjects, being only of utility when joined with the geological description of the country, I must reserve the detail of them for the historical account of my travels in the interior of the New Continent. Thus, without entering into discussions of a minute and purely technical nature, I shall confine myself in this work to the examination of what is conducive to general results.

What is the geographical position of the mines which supply this enormous mass of silver which flows annually from the commerce of Vera Cruz into Europe? Is this enormous mass of silver the produce of a great number of scattered undertakings, or is it to be considered as almost exclusively furnished by three or four metallic veins of extraordinary wealth and *extent?* What is the quantity of precious metals annually extracted from the mines of Mexico? And what proportion does this quantity bear to the produce of the mines of the whole of Spanish America? At how many ounces per quintal may we estimate the mean richness of the silver ore of Mexico? What proportion is there between the quantity of ore which undergoes melting, and that from which the gold and silver are extracted by the process of amalgamation? What influence has the price of mercury

on the progress of mining, and what quantity of mercury is lost in the process of Mexican amalgamation? Can we know with precision the quantity of precious metals which have passed since the conquest of Tenochtitlan from New Spain into Europe and Asia? Is it probable, considering the present method of working, and the geological constitution of the country, that the annual produce of the mines of Mexico will admit of an augmentation? Or shall we admit, with several celebrated writers, that the exportation of silver from America has already attained its *maximum?* These are the general questions which we propose to discuss in this work. They are connected with the most important problems of political economy.

Long before the arrival of the Spaniards, the natives of Mexico, as well as those of Peru, were acquainted with the use of several metals. They did not content themselves with those which were found in their native state on the surface of the earth, and particularly in the beds of rivers, and the ravins formed by the torrents; they applied themselves to subterraneous operations in the working of veins; they cut galleries and dug pits of communication and ventilation; and they had instruments adapted for cutting the rock. Cortez informs us in the historical account of his expedition, that gold, silver, copper, lead, and tin, were publicly sold in the

great market of Tenochtitlan. The inhabitants of Tzapoteca and Mixtecapan* two provinces which now form a part of the intendancy of Oaxaca, separated the gold by means of washing the alluvial soil. These people paid their tribute in two manners, either by collecting in leathern sacks or small baskets of very slender rushes, the grains of native gold, or by founding the metal into bars. These bars, like those now used in trade, are represented in the antient Mexican paintings. In the time of Montezuma, the natives had already begun to work the silver veins of Tlachco (Tasco), in the province of Cohuixco, and those which run across the mountains of Tzumpanco. †

In all the great towns of Anahuac, gold and silver vases were manufactured, although the latter metal was not held in such estimation by the Americans as by the natives of the old continent. The Spaniards, on their first arrival at Tenochtitlan, could never cease admiring the ingenuity of the Mexican goldsmiths, among whom, the most celebrated were those of Azcapozalco and Cholula. When Montezuma, seduced by an extreme credulity, recognized in the arrival of white and bearded men, the accomplishment of the mysterious prophecy of

* Especially the inhabitants of the old towns of Huaxyacac, (Oaxaca), Cojolapan, and Atlacuechahuayan.

† Clavigero, i. 43; ii. 125, 165; iv. 204.

Quetzalcoatl*, and compelled the Aztec nobility to yield homage to the king of Spain, the quantity of precious metals offered to Cortez was estimated at the value of 162,000 *pesos de oro*. "Besides the great mass of gold and silver," says the *conquistador*, in his first letter to the emperor Charles the 5th†, "I was presented with gold plate and jewels of such precious workmanship, that, unwilling to allow them to be melted, I set apart more than a hundred thousand ducats worth of them to be presented to your imperial highness. These objects were of the greatest beauty, and I doubt if any other prince of earth ever possessed any thing similar to them. That your highness may not imagine I am advancing fables, I add, that all which the earth and ocean produce, of which king Montezuma could have any knowledge, he had caused to be imitated in gold and silver, in precious stones, and feathers, and the whole in such great perfection, that one could not help believing he saw the very objects represented. Although he gave me a great share of them for your highness, I gave orders to the natives to execute several other works in gold after designs

* See my work entitled, *Vues des Cordillères des Andes, et Monumens des peuples indigènes de l'Amérique*, p. 30.

† *Lorenzana*, p. 99.—The booty in gold taken by the Spaniards after the taking of Tenochtitlan, was only estimated at 130,000 *castellanos de oro* (l. c. p. 301.)

which I furnished them with, such as images of saints, crucifixes, medals, and necklaces. As the fifth or duty on the silver paid to your highness, amounted to more than a hundred marcs, I gave orders to the native goldsmiths to convert them into plates of various sizes, spoons, cups, and other vessels for drinking. All these works were imitated with the greatest exactness." When we read this passage, we cannot help believing, that we are reading the account of a European ambassador, returned from China or Japan. Yet we can hardly accuse the Spanish general of exaggeration, when we consider that the emperor Charles the 5th, could judge with his own eyes of the perfection or imperfection of the objects sent to him.

The art of founding had also made considerable progress among the Muyscas in the kingdom of New Grenada, among the Peruvians, and the inhabitants of Quito. In this last country, very precious works of the antient American goldsmiths have been preserved for several centuries in the royal treasury (*en caxas reales*). Within these few years, from a system of economy which may be stiled barbarous, these works, which proved that several nations of the New Continent had reached a degree of civilization very superior to what is generally attributed to them, have been all melted down.

The Aztec tribes extracted before the conquest, *lead* and *tin*, from the veins of Tlachco (Tasco, to the north of Chilpansingo) and Izmiquilpan; and they drew *cinnabar*, employed by the painters as a colour, from the mines of Chilapan. Of all the metals, *copper* was that which was most commonly employed in the mechanical arts; it supplied the place of iron and steel to a certain extent; and their arms, axes, chisels, and all their tools, were made of the copper which they extracted from the mountains of Zacotollan and Cohuixco. In every part of the globe, the use of copper seems to have preceded that of iron; and the abundance of copper in its natural state in the most northern parts of America, may have contributed to the extraordinary predilection which the Mexican tribes, who issued from those regions, have always shewn for it. Nature exhibited to the Mexicans enormous masses of iron and nickel; and these masses which are scattered over the surface of the ground, are fibrous, malleable, and of so great a tenacity, that it is with great difficulty a few fragments can be separated from them with steel instruments. The true native iron, that to which we cannot attribute a *meteoric* origin, and which is constantly found mixed with lead and copper, is infinitely rare in all parts of the globe; consequently we are not to be astonished, that in the commencement of civilization, the Ameri-

cans, like most other nations, turned their attention to copper in preference to iron. But how did it happen, that these same Americans, who wrought by means of fire* a great variety of minerals, were never led to the discovery of iron by the mixture of combustible substances with the red and yellow *ocres* †, extremely common in several parts of Mexico? If, on the other hand, this metal was known to them, which I am inclined to believe, how happened it that they never learned to appreciate its just vaiue? These considerations seem to indicate that the civilization of the Aztec nations was not of a very antient date. We know that in the time of Homer, the use of copper still prevailed over that of iron, although the latter had been long known.

Several men of great learning, but unacquainted with chemical knowledge, have maintained, that the Mexicans and Peruvians possessed a particular secret for tempering copper

* According to the traditions collected by me, near Riobamba, among the Indians of the village of Lican, the antient inhabitants of Quito smelted silver ores by stratifying them with charcoal, and blowing the fire with long bambou reeds. A great number of Indians were placed circularly around the hole which contained the minerals; so that the currents of air proceeded at once from several reeds.

† Yellow ocre, called *tecozahuitl*, was employed in painting as well as cinnabar. Ocre was part of the objects which composed the list of tributes of Malinaltepec.

and *converting it into steel.* There is no doubt that the axes and other Mexican tools were almost as sharp as steel instruments; but it was by the admixture of tin, and not by any tempering, that they acquired their extreme hardness. What the first historians of the conquest call *hard* or *sharp copper*, resembled the χαλκος of the Greeks, and the Aes of the Romans. The Mexican and Peruvian sculptors executed large works in the hardest greenstone, (*grünstein*), and basaltic porphyry. The jeweller cut and pierced the emeralds and other precious stones by using at the same time a metal tool and a siliceous powder. I brought from Lima an antient Peruvian chisel, in which M. Vauquelin found 0.94 of copper, and 0.06 of tin. This mixture was so well forged, that by the condensation of the particles, its specific gravity was 8.815, while, according to the experiments of M. Briche *, the chemists never obtain this *maximum* of density, but by alloying 16 parts of tin, with 100 parts of copper. It appears, that the Greeks made use of both tin and iron at the same time in the hardening of copper. Even a Gaulish axe found in France by M. Dupont de Nemours, which cuts wood like a steel axe, without breaking or yielding, contains according to the analysis of M. Vauquelin, 0.87 of copper, 0.03 of iron, and 0.09 of tin.

* *Journal des mines*, An. 5, p. 881.

Tin being a metal very little spread over the globe, it is rather surprising that it should have been used on both Continents in the hardening of copper. A single mineral which has been no where discovered but at Wheal Rock, in Cornwall, the sulphuret of tin (tin-pyrites) contains both copper and tin in equal parts. We know not whether the Mexican nations worked veins in which copper and oxyde of tin were found united, or if this latter metal, which we found in the alluvial soil in the intendancy of Guanaxuato, under the globulous and fibrous form of wood tin (*holz-zinn*) was added to pure copper in a constant proportion. However the fact be, it is certain that the want of iron would be much less felt among nations who possessed the art of forming alloys of other metals, in a manner equally advantageous. The edge-tools of the Mexicans, were some of copper and others of obsidian (*itztli*). The last substance was even the object of great mining undertakings, of which the traces are still to be perceived in an innumerable quantity of pits dug in the *mountain of Knives*, near the Indian village of *Atotonilco el Grande*. *

Besides the cocoa bags, each of which contained three *xiquipilli* or 24,000 grains, besides the *patolquachtli*, or small bales of cotton

* See Vol. ii. p. 66.

cloth, also some metals were used by the antient Mexicans as money, that is to say, as representative signs of things. In the great market of Tenochtitlan, all sorts of goods were purchased with gold dust, contained in tubes of the feathers of aquatic birds. It was requisite that these tubes should be transparent for the sake of discovering the size of the grains of gold. In several provinces, pieces of copper to which the form of a T was given where used as a currency. Cortez relates that having undertaken to found cannons in Mexico, and having dispatched emissaries for the discovery of mines of tin and copper, he learned that in the environs of Tachco (Tlachco or Tasco) the natives employed in exchange, pieces of melted tin *, which were as thin as the smallest coins in Spain.

* Cortez complains in his last letter to Charles the 5th, that after the taking of the capital, he was left without artillery and without arms. "Nothing", says he, "sharpens the "genius of man more (*no hay cosa que mas los ingenios de "los hombres aviva*) than the idea of danger. Seeing myself "on the point of losing what had cost us so much labour in "acquiring, I was obliged to fall upon means of making cannons with the materials to be found in the country." I shall transcribe here the remarkable passage in which Cortez speaks of tin as money: "Topé entre los naturales de una provincia "que se dice Tachco ciertas *piecezuelas de estaño*, a manera da "moneda muy delgada y procediendo en mi pesquisa hallé que "en la dicha provincia y aun en otras, se trataba *por moneda*." (*Lorenzana*, p. 379. § XVII.)

Such is the imperfect idea which the first historians have transmited to us of the use made by the natives of Mexico, of gold, silver, copper, tin, lead, and of the mercury mines. I thought it necessary to enter into these details, not only to throw some light on the antient cultivation of these countries, but also to show that the European colonists in the first years which succeeded the destruction of Tenochtitlan, only followed the indications of mines given them by the natives.

The kingdom of New Spain in its actual state contains nearly 500 places (*reales y realitos*) celebrated for the mines in their environs. More than two thirds of these places are marked in the general map of the country drawn up by me. It is probable that these 500 *reales* comprehend nearly three thousand mines (*minas*), designating by that name the whole of the subterraneous works, which communicate with one another, by which one or more metallic depositories are worked. These mines are divided into 37 districts, over which are placed the same number of Councils of mines called *Diputaciones de Mineria.* We shall collect in one view the names of these *Diputaciones* and of the *Reales de Minas*, contained in the twelve Intendancies of New Spain. The materials employed for this purpose are partly taken from a manuscript memoir drawn up by the

director of the superior council of mines, Don Fausto D'Elhuyar for the Count de Revillagigedo, one of the viceroys.

GENERAL VIEW
OF THE
MINES OF NEW SPAIN.

I. *Intendancy of Guanaxuato.*

From the 20° 55′ to the 21° 30′ of north latitude, and from the 102° 30′ to the 103° 45′ of west longitude.

Diputaciones de Mineria, or Districts.

1. Guanaxuato.

Reales, or Places surrounded with Mines:

Guanaxuato; Villalpando; Monte de San Nicolas; Santa Rosa; Santa Ana; San Antonio de las Minas; Comanja; Capulin; Comanjilla; Gigante; San Luis de la Paz; San Rafael de los Lobos; Durasno; San Juan de la Chica; Rincon de Centeno; San Pedro de los Pozos; Palmas de Vega; San Miguel el Grande; San Felipe.

II. *Intendancy of Zacatecas.*

From the 22° 20′ to the 24° 33′ north latitude, and from the 103° 12′ to the 105° 9′ of west longitude.

Diputaciones de Mineria, or Districts.

2. Zacatecas.
3. Sombrerete.
4. Fresnillo.
5. Sierra de Pinos.

Reales, or Places surrounded by Mines.

Zacatecas; Guadalupe de Veta Grande; San Juan Bauptista de Panuco; La Blanca; Sombrerete; Madroño; San Pantaleon de la Noria; Fresnillo; San Demetrio de los Plateros; Cerro de Santiago; Sierra de Pinos; La Sauceda; Cerro de Santiago; Mazapil.

III. *Intendancy of San Luis Potosi.*

From the 22° 1′ to the 27° 11′ of north latitude, and from the 100° 35′ to the 103° 20′ of west longitude.

Diputaciones de Mineria, or Districts.

6. Catorce.
7. San Luis Potosi.
8. Charcas.
9. Ojocaliente.
10. San Nicolas de Croix.

Reales, or Places surrounded by Mines:

La Purissima Concepcion de Alamos de Catorce; Matehuala; Cerro del Potosi; San Martin Bernalejo; Sierra Negra; Tule; San Martin; Santa Maria de las Charcas; Ramos; Ojocaliente; Cerro de San Pedro; Matanzillas; San Carlos de Vallecillo; San Antonio de la Yguana; Santiago de las Sabinas; Monterey; Jesus de Rio Blanco; Las Salinas; Bocca de Leones; San Nicolas de Croix; Borbon; San Joseph Tamaulipan; Nuestra Señora de Guadalupe de Sihue; La Purissima Conception de Revillagegido; El Venado; L. Tapona; Guadalcazar.

IV. *Intendancy of Mexico.*

From the 18° 10′ to the 21° 30′ of north latitude, and from the 100° 12′ to the 103° 25′ of west longitude.

Diputaciones de Mineria, or Districts.

11. Pachuca.
12. El Doctor.
13. Zimapan.
14. Tasco.
15. Zacualpan.
16. Sultepec.
17. Temascaltepec.

Reales, or plaees surrounded by Mines:

Pachuca; Real del Monte; Moran; Atolonilco

el Chico; Atolonilco el Grande; Zimapan; Lomo del Toro; Las Cañas; San Joseph del Oro; Verdozas; Capula; Santa Rosa; El Potosi; Las Plomosas; El Doctor; Las Alpujarras; El Pinal or los Amotes; Huascazoluya; San Miguel del Rio Blanco; Las Aguas; Maconi; San Christobal; Cardonal; Xacala; Jutchitlan el Grande; San Joseph del Obraje Viejo; Cerro Blanco; Cerro del Sotolar; San Francisco Xichu; Jesus Maria de la Targea; Coronilla or la Purissima Concepcion de Tetela del Rio; Tepantitlan; San Vicente; Tasco; Tehuilotepec; Coscallan; Haucingo, Huautla; Sochipala; Tetlilco; San Esteban; Real del Limon; San Geronimo; Temas caltepec; Real de Ariba; La Albarrada; Yxtapa; Ocotepec; Chalchitepeque; Zacualpan; Tecicapan; Chontalpa; Santa Cruz de Azulaques; Saltepec; Juluapa; Papaloapa; Los Ocotes; Capulatengo; Alcozauca; Totomixtlahuaca.

V. *Intendancy of Guadalaxara.*

From the 19° 0′ to the 23° 12′ of north latitude, and from the 103° 30′ to the 108° 0′ of west longitude.

Diputaciones de Mineria, or Districts.

18. Bolaños.
19. Asientos de Ibarra.
20. Hostotipaquillo.

Reales, or Places surrounded by Mines:

Bolaños; Xalpa; San Joseph de Guichichila; Santa Maria de Guadalupe, or de la Yesca; Asientos de Ibarra; San Nicolas de los Angeles; La Ballena; Talpan; Hostotipaquillo; Copala; Guaxacatan; Amaxac; Limon; Tepanteria; Iocotan; Tecomatan; Ahuatacancillo; Guilotitan; Platanarito; Santo Domingo; Iuchipila; Mezquital; Xalpa; San Joseph Tepostitlan; Guachinango; San Nicolas del Roxo; Amatlan; Natividad; San Joaquin; Santissima Trinidad de Pozole; Tule; Motage; Frontal, Los Aillo-Ezatlannes; Possesion; La Serranilla; Aquitapilco; Eliso; Chimaltitan; Santa Fe; San Rafael; San Pedro Analco; Santa Cruz de las Flores.

VI. *Intendancy of Durango.*

From the 23° 55′ to the 29° 5′ of north latitude, and from the 104° 40′ to the 110° 0′ of west longitude.

Diputaciones de Mineria, or Districts.

21. Chihuahua.
22. Parral.
23. Guarisamey.
24. Cosiguiriachi.
25. Batopilas.

Reales, or Places surrounded by Mines:

San Pedro de Batopilas; Uruachi; Cajurichi; Nuestra Señora de Loreto; San Joaquin de los

Arrieros; El Oro de Topago; San Juan Nepomuceno; Nuestra Señora del Monserrate del Zapote; Uriquillo; San Augustin; Nuestra Señora del Monserrate de Urique; Guarisamey; San Vicente; Guadalupe; Gavilanes; San Antonio de las Ventanas, San Dimas, San Joseph de Tayoltita; Cosiguiriachi; Rio de San Pedro; Chihuahua el Viejo; San Juan de la Cieneguilla; Maguarichi; Caxurichi; San Jose del Parral*; Indehé; Los Sauces; Nuestra Señora de la Merced del Oro; Real de Todos Santos; San Francisco del Oro; Santa Barbara; San Pedro; Huejoquilla; Los Peñoles; La Cadena; Cuencamé, San Nicolas de Yervabuena; La Concepcion; Santa Maria de las Nieves; Chalchihuites; Santa Catalina; San Miguel del Mezquital; Nuestra Señora de los Dolores del Orito; San Juan del Rio; San Lucas; Panuco; Avinito; San Francisco de la Silla; Texamen; Nuestra Señora de Guadalupe de Texame; San Miguel de Coneto; Sianori; Canelas; Las Mesas; Sabatinipa or Matabacas; Topia; San Rafael de las Flores; El Alacran; La Lagartija; San Ramon; Santiago de Mapimi.

* On some proofs of my general map of New Spain, the name of *Parral* is confounded with that of the village of Valle San Bartolomé. The sign by which the chief seat of a provincial council of mines is indicated, points out the true position of Parral.

VII. *Intendancy of Sonora.*

From the 23° 15′ to the 31° 20′ of north latitude, and from the 107° 45′ to the 113° 20′ of west longitude.

Diputaciones de Mineria, or Districts.

26. Alamos.
27. Copala.
28. Cosala.
29. San Francisco Xavier de la Huerta.
30. Guadalupe de la Puerta.
31. Santissima Trinidad de Peña Blanca.
32. San Francisco Xavier de Alisos.

Reales, or Places surrrounded by Mines:

San Joseph de Copala; Real del Rosario; Plomosas; Santa Rosa *or* las Adjuntas; Apomas; San Nicolas de Panuco; Santa Rita; Trancito; Charcas; Limon; Santa Rosa de las Lagunas; Tocusitita; Corpus; Reyes; Cosala; Palo Blanco; El Caxon; Santiago de los Caballeros; San Antonio de Alisos; San Roque; Tabahueto; Norotal; Los Molinos; Surutato; Los Carcamos; San Juan Nepomuceno; Bacatopa; Loreto; Tenoriba; Aguacaliente; Monserrate; Sivirijoa; Baroyeca; Yecorato; Zataque; Cerro Colorado; Los Alamos; Guadalupe; Rio Chico; La Concepcion de Haygame; Santissima Trinidad; La Ventana *or* Guadalupe; Saracachi; San Antonio de la Huerta; San

Francisco Xavier; Hostimuri; Quisuani; El Aguage; Higane; San Jose de Gracia; El Gabilan; El Populo; San Antonio; Todos Santos; El Carizal; Nacatabori; Racuach; San Ildefonso de Cieneguilla; San Lorenzo; Nacumini; Cupisonora; Tetuachi; Basochuca; Nacosari; Bacamuchi; Cucurpe; Motepore.

VIII. *Intendancy of Valladolid.*

From the 18° 25′ to the 19° 50′ of north latitude, and from the 102° 15′ to the 104° 50′ of west longitude.

Diputaciones de Mineria, or Districts.

33. Angangueo.
34. Inguaran.
35. Zitaquaro.
36. Tlalpujahua.

Reales, or Places surrounded by Mines:

Angangueo; El Oro; Tlapaxahua; San Augustin de Ozumatlan; Zitaquaro; Istapa; Los Santos Reyes; Santa Rito de Chirangangeo; El Zapote; Chachiltepec; Sanchiqueo; La Joya; Paquaro; Xerecuaro; Curucupaseo; Sinda; Inguaran; San Juan Guetamo; Ario; Santa Clara; Alvadeliste; San Nicolas Apupato; Rio del Oro; Axuchitlan; Santa Maria del Carmen del Sombrero; Favor; Chichindaro.

IX. *Intendancy of Oaxaca.*

From the 16° 35′ to the 17° 55′ of north latitude, and from the 98° 15′ to the 100° 0′ of west longitude.

Diputaciones de Mineria, or Districts.

37. Oaxaca.

Reales or Places surrounded by Mines:

Zologa; Talea; Hueplotitlan; La Aurora de Ixtepexi; Villalta; Ixtlan; Betolatia; Huitepeque; Rio de San Antonio; Totomistla; San Pedro Nesicho; Santa Catalina; Lachateo; San Miguel Amatlan; Santa Maria Iavecia; San Mateo Capulalpa; San Miguel de las Peras.

X. *Intendancy of Puebla.*

From the 18° 15′ to the 20° 25′ of north latitude, and from the 99° 45′ to the 100° 50′ of west longitude.

Scattered Mines:

La Canada; Tulincingo; San Miguel Tenango; Zautla; Barrancas; Alatlanquetepec; Temetzla; Ixtacmaztitlan.

XI. *Intendancy of Vera Cruz.*

From the 20° 0′ to the 21° 15′ of north latitude, and from the 99° 0′ to the 101° 5′ of west longitude.

Scattered Mines:

Zomelahuacan; Giliapa; San Antonio de Xacala.

XII. *Old California.*

Mine. Real de Santa Ana.

Those who have studied the geological constitution of a mining country of great extent, know the difficulty of reducing to general ideas the observations made on a great variety of beds, and metalliferous veins. The naturalist may distinguish the relative antiquity of the different *formations*, and he is enabled to discover laws, in the stratification of rocks, in the identity of beds, and often even in the angles which they form, either with the horizon or the meridian of the place; but how can he recognize the laws which have determined the disposition of the metals in the bosom of the earth, the extent, the direction, and inclination of the veins, the nature of their *mass*, and their particular structure? How can he draw general results from the observation of a multitude of small phenomena, modified by causes of a purely local nature, and appearing to be the effects of an action of chemical affinities, confined to a very narrow space? These difficulties are increased when it happens, as in the mountains of Mexico, that the *veins*,

the *beds*, and the *masses*, (*stockwerke*) are scattered in an infinity of mixed rocks of very different *formations*. If we possessed an accurate description of the four or five thousand veins actually wrought in New Spain, or which have been wrought within the two last centuries, we should undoubtedly perceive in the materials and structure of these veins, analogies indicative of a simultaneous origin; we should find that these vein materials (*gang-ausfüllungen*) are partly the same with those which are exhibited in the veins of Saxony and Hungary, and on which M. Werner, the first mineralogist of the age, has thrown so much light. But we are yet very far from being acquainted with the metalliferous mountains of Mexico; and notwithstanding the great number of observations collected by myself in travelling through the country in different directions, for a length of more than 400 leagues, I shall not venture to sketch a general view of the Mexican mines, considered under their geological relations, I shall content myself with merely indicating the rocks which yield the greatest part of the wealth of New Spain.

In the present state of the country, the veins are the object of the most considerable operations; and the ores disposed in *beds* or in *masses* are not frequent. The Mexican veins are for the most part found in *primitive* and

transition rocks (ur-und übergangs-gebürge), and rarely in the rocks of *secondary* formation, which only occupy a vast extent of ground to the north of the Tropic of Cancer, to the east of the Rio del Norte, in the basin of the Mississippi, and to the west of New Mexico, in the plains watered by the rivers of Zaguananas and San Buenaventura, which abound in muriatic salts. In the old continent *granite*, *gneiss* and *micaceous slate* (*glimmer-schiefer*) constitute the crest of high chains of mountains. But these rocks seldom basket out on the ridge of the Cordilleras of America, particularly in the central part contained between the 18°, and 22° of north latitude. Strata of amphibolic porphyry, greenstone, amygdaloid, basalt and other trap formations of an enormous thickness, cover the granite, and conceal it from the geologist. The coast of Acapulco is formed of granitic rocks. Ascending towards the table land of Mexico, we see the granite pierce through the porphyry for the last time between Zumpango and Sopilote. Farther to the east, in the province of Oaxaca, the granite and gneiss are visible in table lands of considerable extent traversed by auriferous veins.

Tin, which after Titanium, Scheelin, and Molybdena, is the oldest metal of the globe, has never yet, as far as I know, been observed in the granites of Mexico; for the fibrous tin (*wood-tin*) of the

Gigante belongs to alluvial rocks, and the veins of tin of the Sierra de Guanaxuato are found in mountains of porphyry. In the mines of Comanja, a *syenite*, apparently of antient formation, contains an argentiferous vein. That of Guanaxuato, the richest of all America, traverses a *primitive slate* (*thon-schiefer*) which frequently passes into *talk-slate* (*talk-schiefer*). The *serpentine* of Zimapan appears destitute of metals.

The *porphyries* of Mexico may be considered for the most part as rocks eminently rich in ores of gold and silver. One of the problems of geology, the most difficult to resolve, is the determination of their *relative antiquity*. They are all characterised by the constant presence of amphibole and the absence of quartz, so common in the primitive porphyries of Europe, and especially in those which form beds in gneiss. The *common feldspar* is rarely to be seen in the Mexican porphyries; and it belongs only to the most antient formations, those of Pachuca, Real del Monte, and Moran, where the veins furnish twice as much silver as all Saxony. We frequently discover only *vitreous feldspar* in the porphyries of Spanish America. The rock which is intersected by the rich gold vein of Villalpando, near Guanaxuato, is a porphyry, of which the basis is somewhat akin to *klingstein* (*phonolite*), and

in which amphibole is extremely rare. Several of these parts of New Spain bear a great analogy to the problematical rocks of Hungary, designated by M. de Born by the very vague denomination of *saxum metalliferum*. The veins of Zimapan, which are the most instructive in respect to the theory of the repositories of minerals, traverse porphyries of a *greenstone* base which appear to belong to trap rocks of a newer formation. These veins of Zimapan offer to oryctognostic collections a great variety of interesting minerals, such as fibrous zeolite, stilbite, grammatite, pycnite, native sulphur, fluor spar, barytes, suberiform asbestus, green garnets, carbonate and chromate of lead, orpiment, chrysoprase, and a new species of opal of the rarest beauty, which I made known in Europe, and which M. M. Karsten and Klaproth have described under the name of fire opal.

Among the *transition rocks* which contain ores of silver, we may mention the transition-limestone (*übergangs-kalkstein*) of the Real del Cardonal, of Xacala, and of Lomo del Toro, to the north of Zimapan. In the last of these places what is worked are not veins, but masses of galena, of which some have yielded in a short space of time, according to the observation of M. Sonneschmidt, more than 124,000 quintals of lead. The *grauwacke* alternating

with *grauwacke-slate* is equally rich in metals in Mexico as in several parts of Germany. In this rock, the formation of which immediately preceded that of the secondary rocks, several of the veins of Zacatecas appear to be found.

In proportion as the north of Mexico shall be examined by intelligent geologists, it will be perceived that the metallick wealth of Mexico does not exclusively belong to primitive formations and transition rocks, but extend also to those of *secondary formation*. I know not whether the lead which is procured in the eastern parts of the intendancy of San Luis Potosi is found in veins or beds; but it appears certain, that the veins of silver of the Real de Catorce, as well as those of the Doctor and Xaschi near Zimapan, traverse *alpine limestone* (*alpenkalkstein*); and this rock rests on pudding-stone, with silicious cement, which may be considered as the most antient of secondary formations. The alpine limestone, and the jura limestone (*jurakalkstein*), contain the celebrated silver mines of Tasco and Tehuilotepec, in the intendancy of Mexico; and it is in these calcareous rocks that the numerous veins which in this country have been very early wrought, display the greatest wealth. They are less productive in the strata of primitive slate (*urthon-schiefer*), which is as seen in the

Cerro de San Ignacio, serves for base to the secondary formations.

The result of this general view of the metalliferous repositories (erzführende lagerstätte) is, that the cordilleras of Mexico contain veins in a great variety of rocks, and that those rocks, which at present furnish almost the whole silver annually exported from Vera Cruz, are, *primitive slate*, *grauwacke*, and *alpine lime stone*, intersected by the *principal veins* of Guanaxuato, Zacatecas, and Catorce. It is also in *primitive slate* (*urthon-schiefer*), on which rests a clayey porphyry containing garnets, that the wealth of *Potosi*, in the kingdom of Buenos Ayres, is contained. On the other hand, in Peru the mines of Gualgayoc or Chota, and that of Yauricocha or Pasco, which together yield annually double the quantity of all the German mines, are found in an *alpine limestone*. The more we study the geological constitution of the globe on a large scale, the more we perceive that there is scarcely a rock which has not in certain countries been found eminently metalliferous. The wealth of the veins is for the most part totally independent of the nature of the beds which they intersect.

We observe in the most celebrated mines of Europe, that the mining operations are either directed to a multitude of small veins, as in the primitive mountains of Saxony, or to a very

small number of *depositories of minerals* of an extraordinary power, as at Clausthal, the Harz, and near Schemnitz in Hungary. The cordilleras of Mexico offer frequent examples of these two methods of operation; but the districts of mines of the most constant and considerable wealth, Guanaxuato, Zacatecas, and the Real del Monte, contain only one principal vein each (*veta madre*). The vein called *halsbrükner spath*, of which the extent is two metres*, and which has been traced for a length of 6200 metres†, is spoken of as a remarkable phenomenon at Freiberg. The *veta madre* of Guanaxuato, from which there has been extracted, during the course of the last ten years, more than six millions of mares of silver‡, is of the extent of from 40 to 45 metres §, and it is wrought from Santa Isabella and San Bruno to Buena-Vista, a length of more than 12,700 metres.‖

In the Old Continent, the veins of Freiberg and Clausthal, which intersect mountains of *gneiss* and *grauwacke*, are visible in table lands of which the elevation above the level of the sea is only from 350 to 570 metres¶; and this

* 6½ feet. *Trans.*
† 20, 341 feet. *Trans.*
‡ 3,937,899lb. troy. *Trans.*
§ From 131 to 147 feet. *Trans.*
‖ 41,665 feet. *Trans.*
¶ From 1148 to 1869 feet. *Trans.*

elevation may be regarded as the mean height of the most abundant mines in Germany. But in the New Continent the metallic wealth is deposited by nature on the very ridge of the cordilleras, and sometimes in situations within a very small distance from the limit of perpetual snow. The most celebrated mines in Mexico are at absolute heights of from 1800 to 3000 metres.* In the Andes, the districts of mines of Potosi, Oruro, Paz, Pasco and Gualgayoc, are in regions of which the elevation surpasses that of the highest summits of the Pyrenees. Near the small town of Micuipampa, the great square of which, according to my measurement, is 3618 metres† above the level of the sea, a depôt of silver ore known by the name of *Cerro de Gualgayoc* was found to yield immense wealth at an absolute height of 4100 metres.‡

We have mentioned in another place§ the advantage which in working the Mexican mines, is derived from the most important veins being in a middle region, where the climate is not unfavourable to agriculture and vegetation. The large town of Guanaxuato is placed in a ravin, the bottom of which is somewhat

* From 5904 to 9842 feet. *Trans.*

† 11,868 feet. *Trans.*

‡ 13,451 feet. *Trans.*

§ See vol. i. p. 71., and vol. ii. p. 407.

lower than the level of the lakes of the valley of Tenochtitlan. We are ignorant of the absolute heights of Zacatecas and the Real de Catorce; but these two places are situated on table lands seemingly more elevated than the level of Guanaxuato. However, the temperate climate of these Mexican towns, which are surrounded with the richest mines in the world, is a contrast to the cold and exceedingly disagreeable climate of Micuipampa, Pasco, Huancavelica and other Peruvian towns.

When in a district of small extent, for instance, in that of Freiberg in Saxony, we compare the quantity of silver annually coined, with the great number of mines constantly worked, we perceive, on the slightest examination, that this produce is derived from a very small part of the mining operations, and that nine tenths of the mines possess almost no influence on the total mass of ores extracted from the bowels of the earth. In the same manner, in Mexico, the 2,500,000 marcs* of silver which are annually sent to Europe and Asia, from the ports of Vera Cruz and Acapulco, are the produce of a very small number of mines. The three districts which we have frequently had occasion to name, Guanaxuato, Zacatecas, and Catorce, supply more than the half of that sum.

* 1,640,791 lb. troy. *Trans.*

The vein of Guanaxuato alone yields more than a fourth part of the whole silver of Mexico, and a sixth part of the produce of all America.

In the general view already presented by us, the principal mines are confounded with those from which a very small quantity of metal is extracted. The disproportion between the two classes is so great, that more than $\frac{19}{20}$ of the Mexican mines belong to the latter, of which the total produce does not probably amount to the sum of 200,000 marcs.* In Saxony also the mines which surround the town of Freiberg produce annually nearly 50,000 marcs of silver, while all the rest of the *Erzgebirge* does not yield more than from seven to eight thousand marcs. The following is the order in which the richest mines of New Spain follow one another, arranging them according to the quantity of money actually drawn from them:

Guanaxuato, in the Intendancy of the same name.

Catorce, in the Intendancy of San Luis Potosi.

Zacatecas, in the Intendancy of the same name.

Real del Monte, in the Intendancy of Mexico.

Bolaños, in the Intendancy of Guadalaxara.

* 131,263 lb. troy. *Trans.*

Guarisamey, in the Intendancy of Durango.

Sombrerete, in the Intendancy of Zacatecas.

Tasco, in the Intendancy of Mexico.

Batopilas, in the Intendancy of Durango.

Zimapan, in the Intendancy of Mexico.

Fresnillo, in the Intendancy of Zacatecas.

Ramos, in the Intendency of San Luis Potosi.

Parral, in the Intendancy of Durango.

We are absolutely in want of accurate materials for tracing the history of the mining operations of New Spain. It appears certain, that of all the veins, those of Tasco, Zultepeque, Tlapujahua and Pachuca, were first wrought by the Spaniards. Near Tasco, to the west of Tehuilotepec, in the *Cerro de la Campana*, Cortez cut a level across the micaceous slate, which is, as we have already stated, overlaid by alpine lime stone. This gallery, called *el socabon del rey*, was begun on such a large scale that one may go through it on horseback for a length of more than 90 metres*; and it has been lately finished by the patriotic zeal of Don Vicente de Anza, a miner of Tasco, who was enabled to cut the principal vein at the distance of 530 metres from the mouth of the level. The working of the mines of Zacatecas followed very closely that of the mineral repositories of Tasco and Pachuca. The vein of San

* 295 feet. *Trans.*

Barnabè was begun in the year 1548, twenty-eight years after the death of Montezuma, a circumstance which must appear so much the more remarkable, as the town Zacatecas is distant, in a straight line, more than 100 leagues from the valley of Tenochtitlan. It is said that the silver ores of the district of Zacatecas were discovered by the muleteers who travelled between Mexico and Zacatecas. In this district, near the basaltic hill of *Cubilete*, the mine of San Barnabè exhibits the most antient mining operations. The principal vein of Guanaxuato (*la veta madre*) was discovered somewhat later, on sinking the shafts of *Mellado* and *Rayas*. The first of these shafts was begun on the 15th, and the second on the 16th of April in the year 1558. The mines of Comanjas are undoubtedly still more antient than those of Guanaxuato. As the total produce of the mines of Mexico, till the beginning of the 18th century, has never been more than 600,000 marcs of gold and silver a year, we may conclude, that in the 16th century they did not labour with very great activity in the extraction of the ores. The veins of Tasco, Tlapujahua, Sultepeque, Moran, Pachuca, and Real del Monte, and those of Sombrerete, Bolaños, Batopilas, and Rosario, have afforded from time to time immense wealth; but their produce has been less uniform than that of the mines of Guanaxuato, Zacatecas, and Catorce.

The silver extracted in the 37 mining districts into which the kingdom of New Spain is divided, is deposited in the *Provincial Treasuries*, established in the chief places of the Intendancies; and it is from the receipts of these *caxas reales* that we are to judge of the quantity of silver furnished by the different parts of the country. The following is an account of the receipts of 11 Provincial Treasuries:

From 1785 to 1789, there was received in the *Caxas Reales* of

	Marcs of Silver.
Guanaxuato	2,469,000
San Luis Potosi (Catorce, Charcas, San Luis Potosi)	1,515,000
Zacatecas (Zacatecas, Fresnillo, Sierra de Pinos)	1,205,000
Mexico (Tasco, Zacualpa, Zultepeque)	1,055,000
Durango (Chihuahua, Parral, Guarisamey, Cosiguiriachi)	922,000
Rosario (Rosario, Cosala, Copala, Alamos)	668,000
Guadalaxara (Hostotipaquillo, Asientos de Ybarra)	509,000
Pachuca (Real del Monte, Moran)	455,000
Bolaños	364,000
Sombrerete	320,000
Zimapan (Zimapan, Doctor)	248,000
Sum for five years,	9,730,000

That part of the Mexican mountains which at present contains the greatest quantity of silver, is contained between the parallels of 21 and 24½ degrees. The celebrated mines of Guanaxuato are only distant, in a straight line,

from those of San Luis Potosi, 30 leagues: from San Luis Potosi to Zacatecas, the distance is 34 leagues; from Zacatecas to Catorce, 31, and from Catorce to Durango, 74 leagues. It is remarkable enough that this metallick wealth of Mexico and Peru should be placed at an almost equal distance in the two hemispheres from the equator.

In the vast extent which separates the mines of Potosi and la Paz from those of Mexico, there are no others which throw into circulation a great mass of the precious metals, but Pasco and Chota. Advancing from the Cerro de Gualgayoc northwards, we find only the gold stream works at Choco, and in the province of Antioquia, and the recently discovered silver veins of Vega de Supia. It is the same with the Cordillera of the Andes, as with all the mountains of Europe, in which metals are very unequally distributed. The province of Quito, and the Eastern part of the kingdom of New Granada, from the 3° of South latitude, to the 7° of North latitude; the Isthmus of Panama, and the mountains of Guatimala, contain, for a length of 600 leagues, vast extents of ground, in which no vein has hitherto been wrought with any degree of success. It would not, however, be accurate to advance that these countries which have, in a degree, been convulsed with volcanos, are entirely destitute of gold and silver ore. Numerous metalliferous depositories may be concealed

by the super position of strata of basalt, amygdaloid, porphyry with *greenstone* base, and other rocks, comprehended by geologists under the general name of *trapp-formation*.

With respect to the Mexican mines in particular, they may be considered as forming eight *groups* (*Erz-refiere*), which are almost all placed either on the ridge or on the Western slope of the Cordillera of Anahuac. The *first* of these groups is the most considerable in produce; it includes the contiguous districts of Guanaxuato, San Luis Potosi, Charcas, Catorce, Zacatecas, Asientos de Ybarra, Fresnillo, and Sombrerete. The mines situated to the West of the town of Durango, as well as those of the province of Cinaloa, belong to the *second*; for the mines of Guarisamey, Copala, Cosala, and Rosario are near enough to one another to be classed under the same geological division. The *third* group, the most northern of New Spain, is that of Parral, which comprehends the mines of Chihuahua and Cosiguiriachi. It extends from the 27° to the 29° of latitude. To the north-north-east of Mexico, the Real del Monte or Pachuca, and those of Zimapan, or the Doctor, may be stiled the *fourth* and *fifth* groups. Bolaños (in the Intendancy of Guadalaxara), Tasco, and Oaxaca are the central points of the *sixth*, *seventh*, and *eighth* groupes of mines of New Spain. This general view is sufficient

to prove that this kingdom, like the antient Continent, contains vast extents of country, apparently almost totally destitute of metalliferous veins. No considerable operation has been hitherto carried on in the Intendancies of Puebla and Vera Cruz, or in the plains of secondary formation, situated on the left bank of the Rio del Norte, or in New Mexico.

The following table indicates not the *relative wealth*, or unequal distribution of the metals, considered in a geographical point of view, but the quantity of money, which in the present state of the mines is extracted from the different parts of the kingdom of New Spain. We have classed the mines according to the order already laid down, indicating the name of the chief place which is the central point of the group, and the surface of the country in which the different works are to be found. Several groupes are naturally divided into districts, which form so many subdivisions or particular systems.

Principal mines of Mexico, divided into eight groups.	Extent of country occupied by each group of mines, in square leagues.	Places which may be considered as the central points of these 8 groups.	Annual produce of each group in marcs of silver.
1st. *Group* (*Central Group*) from 21° 0′ to 24° 10′ north lat. and from 102° 30′ to 105° 15′ of west long.	1900	Guanaxuato, Catorce, Zacatecas	1,300,000
2nd. *Group* (*Group of Durango and Sonora*) from 23° to 24° 45′ of north lat. and from 106° 30′ to 109° 50′ of west long.	2800	Guarisamey (Durango), Rosario (Copala)	400,000
3rd. *Group* (*Group of Chihuahua*) from 26° 50′ to 29° 10′ of north lat. and from 106° 45′ to 108° 50′ of west long.	3100	Cosiquiriachi, Parral, Batopilas	Doubtful
4th. *Group* (*Group of la Biscaina*) from 20° 5′ to 20° 15′ of north lat. and from 100° 45′ to 100° 52′ of west long.	25	Real del Monte (Pachuca)	120,000
5th. *Group* (*Group of Zimapan*) from 20° 40′ to 21° 30′ of north lat. and from 100° 30′ to 102° 0′ of west long.	7500	Zimapa	60,000
6th, *Group* (*Group of New Gallicia*) from 21° 5′ to 22° 30′ of north lat. and from 105° 0′ to 106° 30′ of west long.	1050	Bolaños	230,000
7th. *Group* (*Group of Tasco*) from 18° 10′ to 19° 20′ of north lat. and from 101° 30′ to 102° 45′ of west long.	1200	Temescaltepec, Tasco, Zacualpa	260,000
8th. *Group* (*Group of Oaxaca*) from 16° 40′ to 18° 0′ of north lat. and from 98° 15′ to 99° 50′ of west long.	1400	Oaxaca, Villalta	Doubtful

	Marcs of silver.
Mean Produce of the Mines of New Spain, including the Mines of the northern part of New Biscay, and those of Oaxaca, above	2,500,000

We shall afterwards compare the produce of the silver mines of Mexico, with that of the different mines of Europe. It will suffice in this place to observe, that the two millions and a half of marcs of silver annually exported from Vera Cruz, *are equal to two thirds of the silver annually extracted from the whole globe.* The eight groups into which we have divided the mines of New Spain, occupy a surface of 12,000 square leagues, or a tenth of the whole extent of the kingdom. When we look at the immense wealth of a very small number of mines, for example, the mine of Valenciana, and that of Reyas at Guanaxuato, or the principal veins, (*vetas madres*) of Catorce, Zacatecas, and Real del Monte, we easily perceive that more than 1,400,000 marcs of silver are produced in an extent of surface, not equal in size to that of the district of the mines of Freiberg.

If the quantity of silver annually extracted from the mines of Mexico is ten times greater than what is furnished by all the mines of Europe, on the other hand, gold is not much more abundant in New Spain than in Hungary and Transylvania. These two last countries annually throw into circulation nearly

5,200 marcs; and the gold delivered into the mint of Mexico, only amounts in ordinary years to 7000 marcs. We may reckon that in times of peace, when the want of mercury does not impede the process of amalgamation, the annual produce of New Spain is,

In *Silver*, 22 millions of Piastres
In *Gold*, 1
—
23

The Mexican *gold* is for the most part extracted from alluvial ground, by means of washing. These grounds are common in the province of Sonora, which as we have already observed *, may be considered as the Choco of North America. A great deal of gold has been collected among the sands, with which the bottom of the valley of the Rio Hiaqui, to the east of the missions of Tarahumara, are covered. Farther to the north in Pimeria Alta, under the 31° of latitude, lumps of native gold (*pepitas*) have been found of the weight of from five to six pounds. In these desert regions, the incursions of the savage Indians, the excessive price of provisions, and the want of the necessary water for working, are all great obstacles to the extraction of gold.

Another part of the Mexican gold is extracted from the veins, which traverse the primitive mountains. The veins of native gold

* Vol. ii. p. 299.

are most frequent in the province of Oaxaca, either in gneiss or micaceous slate (*glimmer-schiefer*). This last rock is particularly rich in gold, in the celebrated, mines of Rio San Antonio. These veins, of which the *gangue* is milk quartz, are more than half a metre in thickness *, but their richness is very unequal. They are frequently *strangled*, and the extraction of gold in the mines of Oaxaca, is in general by no means considerable. The same metal is to be found either pure or mixed with silver ore, in the greatest number of veins which have been wrought in Mexico; and there is scarcely a single silver mine which does not also contain gold. Native gold is frequently found crystallized in octahedrons, or as laminæ, or in a reticulated form, in the silver ores of the mines of Villalpando and Rayas near Guanaxuato, in those of Sombrero (intendancy of Valladolid), Guarisamey to the west of Durango, and Mezquital in the province of Guadalaxara. The gold of Mezquital is looked upon as the purest, that is to say, as being least alloyed with silver, iron, and copper. The principal vein in the mine of Santa Cruz, at Villalpando, which I visited in the month of September 1803, is traversed by a great number of small *rotten* veins, (*hilos*

* 1.6 foot. *Trans.*

del desposorio) of exceeding richness. The argillaceous loam, with which these small veins are filled, contains so great a quantity of gold disseminated in impalpable particles, that the miners are compelled, when they leave the mine nearly in a state of nakedness, to bathe themselves in large vessels, to prevent any of the auriferous clay from being carried off by them on their bodies. The silver ore of Villalpando generally contains only two ounces of gold per load, (*carga* of 12 arrobas); but it frequently contains even eight or ten ounces per load, or $1\frac{7}{10}$ ounces per quintal. It may be of use to mention here that at the Harz, the pyrites of the Rammelsberg, contains only a 29 millionth part of gold, which is however extracted with profit. *

The District of the mines of Guanaxuato, has furnished according to the registers of the Provincial Treasury, †

Periods.	Marcs of Gold.	Marcs of Silver.	Gold contained in the silver.
From 1766 to 1775	9,044	3,422,414	0.0026
1776—1785	13,254	5,281,214	0.0024
1786—1795	7,376	5,609,356	0.0013
1796—1803	13,356	4,410,553	0. 029
In 38 years - -	43,08 0	18,723,537	0.0023

* *Brangniart, Minéralogie*, t. ii. p. 345.

† *Estado de la Tresoreria pincipal de Real Hacienda de Guanaxuato, del 21 de Novembre de* 1799, (M. S.)

The result of this table is that the silver extracted from the vein of Guanaxuato, contains from one to three thousand parts of its weight in gold.

Platina is erroneously stated to be found in the auriferous sands of Sonora. This metal has never yet been discovered to the north of the Isthmus of Panama, on the Continent of North America. Platina in grains is only found in two places of the known world; in Choco one of the provinces of the kingdom of New Granada, and near the shores of the South Sea, in the province of Barbacoas, between the 2° and 6° of north latitude. It is peculiar to the alluvial soil of a surface of 600 square leagues, the extent of which is scarcely equal to two of the departments of France. The stream-works (*lavaderos*), which at present yield the greatest quantity of platina, are those of Condoto, Santa Rita, or Viroviro, and Santa Lucia, and the Ravin (*quebrada*) of Iro, between the villages of Novita and Taddó. There are several gold stream-works in Choco, (for instance, those of the districts of San Augustin and Guaicama,) where no trace of platina is to be found. The price of this metal in grain on the spot is eight piastres, or 40 francs the pound, while at Paris it is generally from 130 to 150 francs. I shall examine in another place the quantity of platina,

which in the present state of the mines of Choco, America can furnish to Europe. It is also an absolutely false assertion, that platina has ever been found near Carthagena or Santa Fe, at the Islands of Porto Rico and Barbadoes, and in Peru*, although these different localities are pointed out in the most esteemed and popular works. Perhaps it will one day be proved by chemical analysis, that platina exists in several silver ores of Mexico, as it exists in the *fahlerz* (grey-copper) of Guadalcanal in Spain.

The silver supplied by the veins of Mexico, is extracted from a great variety of ores, which from the nature of their mixture, bear an analogy to those of Saxony, the Harz, and Hungary. The traveller must not expect to find a complete collection of these ores in the school of mines of Mexico. The mines being all in the hands of individuals, and the Mexican government possessing but a very feeble influence on

* *Hauy Mineralogie*, t. iii. p. 370. In a memoir inserted in the *Anales de Ciencias Naturales*, published by the Abbé Cavannilles, we read that platina is found in *Chopo*, (Choco?) at *Barbados*, (Barbacoas?) and at Carthagena a sea port, a hundred and thirty leagues distant from the gold *lavaderos* of Taddò. Yet more than 18 years ago, M. Berthollet communicated a very accurate account of the places where platina is procured (*Annales de Chimie*, Juillet 1792) I brought to Europe a *pepita* of platina of an extraordinary size. It weighs 1088$\frac{8}{10}$ grains; and its specific weight, is according to M. Tralles, 18,947. (*Karsten, Min. Tabellen*, 1808, p. 96.)

the administration of the mines, it was not in the power of the professors to collect whatever had any relation to the structure of *veins*, *beds*, and *masses* of ores. At Mexico as well as Madrid, the public collections contain the rarest minerals of Siberia and Scotland, while we vainly seek what might throw light on the mineralogical geography of the country. We must hope that the cabinet of the school of mines will become gradually richer, when the pupils of this fine establishment shall be sent into the most distant provinces from the capital, and have proved to the proprietors of mines how much it is for their interest, that the means of instruction should be facilitated. Without a knowledge of the localities in detail, and without a deep study of the minerals of which the *mass* of the veins, or the contents of the lodes and beds are composed, all the changes which may be proposed for the improvement of the process of amalgamation, will turn out mere chimerical projects.

In Peru, the greatest part of the silver extracted from the bowels of the earth, is furnished by the *pacos*, an ore of an earthy appearance, which M. Klaproth was so good as to analyse at my request *, and which consist of

* *Klaproth, Beiträge zur chemischen Kenntniss der Mineral Körper*, b. iv. § 4.

a mixture of almost imperceptible particles of native silver, with brown oxyde of iron. In Mexico, on the other hand, the greatest quantity of silver annually brought into circulation, is derived from those ores which the Saxon miner calls by the name of *dürre erze* * especially from *sulphuret of silver*, (or vitreous silver) from *arsenical* (*fahlerz*), and *antimonial grey copper*, (*grau* or *schwarzgiltigerz*) from *muriate of silver*, (*hornerz*), from *prismatic black silver*, (*sprödglaserz*), and from red silver (*rothgiltigerz*). We do not name native silver among these ores, because it is not found in sufficient abundance to admit of any very considerable part of the total produce of the mines of New Spain being attributed to it.

Sulphuret of silver, and *black prismatic silver*, are very common in the veins of Guanaxuato and Zacatecas, as well as in the *veta Biscaina* of Real del Monte. The silver extracted from the ore of Zacatecas, exhibits the remarkable particularity of not containing gold. The richest grey copper, (*fahlerz*) is that of Sierra de Pinos, and the mines of Ramos. In the latter, the *fahlerz* is accompanied with *glaserz*, with

* See the very instructive work of M. Daubuisson, under the title of *Description des Mines de Freiberg*. I have followed in the course of this chapter, in whatever relates to the art of mining, and the mode of occurring of minerals, the terminology of M. M. Brochant, Daubuisson, and Brongniart.

variegated copper ore (*bunt kupfererz*), sulphuret of zinc and vitreous copper (*kupferglas,*) which is only wrought for the extraction of the silver, without applying the copper to any use. The *graugiltigerz* or antimoniated grey copper described by Mr. Karsten, is found at Tasco, and in the mine of Rayas, south east from Valenciana. The muriate of silver which is so seldom found in the veins of Europe, is very abundant in the mines of Catorce, Fresnillo, and the Cerro San Pedro, near the town of San Luis Potosi. That of Fresnillo is frequently of an olive green, which passes into leek-green. Superb specimens of this colour have been found in the mines of Vallorecas, which belong to the district de los Alamos in the intendancy of Sonora. In the veins of Catorce, the muriate of silver is accompanied with molybdate of lead, (*gelb blei-erz*) and phosphate of lead (*grün blei-erz.*) From the last analysis of Mr. Klaproth, it appears that the muriate of silver of America *, is a pure mixture of silver and muriatic acid, while that of Europe contains oxid of iron, alumine, and especially a little sulphuric

* The Mineralogists at present distinguish four kinds of muriate of silver, the common, the earthy, the conchoidal, and the radiated. The two last species, which are exceedingly beautiful, have been described by Mr. Karsten: they are among the minerals brought by me from Peru. *Karsten*, in the *Magazine der Berliner Gesellschaft Naturforschender Freunde*, b. i. § 156. *Klaproth's Beiträge*, b. iv. § 10.

acid. The red silver ore constitutes a principal part of the wealth of Sombrerete, Cosala, and Zolaga, near Villalta, in the province of Oaxaca. From this ore more than 700,000 marcs of silver have been extracted, in the famous mine of *la Veta Negra* * near Sombrerete, in the space of from five to six months. It is affirmed that the mine which produced this enormous quantity of metal, the greatest which was ever yielded by any vein on the same point of its *mass*, was not thirty metres in length. † The true *white silver ore*, (weissgiltig-erz) is very rare in Mexico. Its *greyish white* variety, very rich in lead, is found, however, in the intendancy of Sonora, in the veins of Cosala, where it is accompanied with argentiferous galena, red silver, brown blende, quartz and sulphate of barytes. This last substance, which is very uncommon among the *gangues* of Mexico, is to be also found at the Real del Doctor, near Baranca de las Tinajas, and at Sombrerete, particularly in the mine called Campechana. Fluor-spar has been only found hitherto in the veins of Lomo del Toro, near Zimapan, at Bolaños and Guadalcazar, near Catorce. It is constantly of a grass green or violet blue colour.

In some parts of New Spain, the operations of the miner are directed to a mixture of

* See vol. i. c. vii.

† 98 feet. *Trans.*

brown oxide of iron, and native silver, disseminated in particles imperceptible to the naked eye. This ochreous mixture, which they call *paco* in Peru, and of which we have already had occasion to speak, is the object of considerable operations at the mines of Angangueo, in the intendancy of Valladolid, as well as at Yxtepexi, in the province of Oaxaca. The ores of Angangueo, known by the name of *colorados*, have a clayey appearance. Near the surface, the brown oxide of iron is mixed with native silver, with sulphuret of silver, and black prismatic silver (*sprödglaserz*), all three in a state of decomposition. At great depths, the vein of Angangueo contains only galena and iron pyrites, yielding but a small quantity of silver. Hence the blackish *pacos*, of the mine of Aurora d'Yxtepexi, whieh must not be confounded with the *negrillos* of Peru, owe their richness rather to the *glaserz*, than to the imperceptible filaments of native dendritic silver. The vein is very unequal in its produce, sometimes sterile, and sometimes abundant. The *colorados* of Catorce, particularly those of the mine of Conception, are of a tile-red color, and mixed with muriate of silver. In general it is observed both in Mexico and Peru, that those oxidated masses of iron which contain silver, are peculiar to that part of the veins, nearest to the surface of the earth. The *pacos*

of Peru present to the eyes of the geologist, a very striking analogy with the earthy masses called by the miners in Europe the *iron hat* (*eiserne huth*) of the veins.

Native Silver, which is much less abundant in America than is generally supposed, has been found in considerable masses, sometimes weighing more than 200 kilogrammes *, in the mines of Batopilas in New Biscay. These mines, which are not very briskly wrought at present, are among the most northern of New Spain. Nature exhibits the same minerals there that are found in the vein of Kongsberg in Norway. Those of Batopilas contain filiform, dentritic and knitted silver, traversing strata of limestone. Native silver is constantly accompanied by *glaserz* in the veins of Mexico, as well as in those of the mountains of Europe, These very minerals are frequently found united in the rich mines of Sombrerete, Madroño, Ramos, Zacatecas, Hapujaha and Sierra de Penos. From time to time small branches, or cylindrical filaments of native silver, are also discovered in the celebrated vein of Guanaxuato; but these masses have never been so considerable as those which were formerly drawn from the mine *del Encino* near Pachuca and Tasco, where native silver is sometimes contained in

* 444lb. avoird.

foliated gypsum. At Sierra de Pinos near Zacatecas, this metal is constantly accompanied with blue radiated copper (*strahlige kupferlazur*) crystallized in small four sided prisms.

A great part of the silver annually produced in Europe, is derived from the *argentiferous sulphuret of lead* (*silberhaltiger bleiglanz*) which is sometimes found in veins traversing *primitive and transition mountains*, and sometimes in particular strata (*erzflöze*) in rocks of *secondary formation*. In the kingdom of New Spain, the greatest part of the veins contain likewise some argentiferous galena; but there are very few mines in which the lead ore is a particular object of their operations. Among the latter, we can only include the mines of the districts of Zimapan, Parral, and San Nicholas de Croix. I observed that at Guanaxuato, as well as several other mines in Mexico *, and every where in Saxony, the varieties of galena contain the more silver, the finer they are in the grain.

* Among the varietes of galena, particularly rich in silver, and of very fine grain, may be specified those of the new mine of Talpan, in the Cerro de las Vegas, belonging to the district of Hostotipaquillo. This galena, which sometimes passes into *compact antimonial sulphuret of lead* (*bleischweif*) is accompanied with much copper pyrites, and carbonate of lime.

A very considerable quantity of silver is produced from the smelting of iron pyrites (*gemeiner schwefelkies*) of which New Spain sometimes exhibits varieties richer than the *glaserz* itself. It has been found in the Real del Monte, on the vein of Biscaina, near the pit of San Pedro, the quintal of which contained even so much as three marcs of silver. At Sombrerete, the great abundance of pyrites disseminated in the red silver ore, is a great obstacle to the process of amalgamation.

We have described the ores which produce the Mexican silver, and it remains for us to examine into the *mean riches* of these minerals, considering them as all mixed together. It is a very common prejudice in Europe, that great masses of native silver are extremely common in Mexico and Peru, and that in general the mineralised silver ores destined to amalgamation or smelting, contain more ounces, or more marcs of silver to the quintal, than the *poor* ores of Saxony and Hungary. Full of this prejudice, I was doubly surprised on my arrival in the Cordilleras to find that the number of *poor mines* greatly surpasses those of the mines to which in Europe we give the name of *rich*. A traveller who visits the famous mine of Valenciana in Mexico, after having examined the *metalliferous* repositories of Clausthal, Freiberg,

and Schemnitz, can scarcely conceive how a vein which, for a great part of its extent contains the sulphuret of silver disseminated in the *gangue* in almost imperceptible particles, can regularly supply thirty thousand marcs per month, a quantity of silver equal to the half of what is annually furnished by all the mines of Saxony. It is no doubt true that *blocks* of *native silver* (*papas de plata*) of an enormous weight, have been extracted from the mines of Batopilas in Mexico and Guantahajo in Peru; but when we study attentively the history of the principal mines of Europe, we find that the *veins* of Kongsberg in Norway, Schneeberg in Saxony, and the famous metallic repository of Schlangenberg in Siberia, have produced masses of much more considerable bulk. We are not in general to judge from the size of the blocks, of the wealth of the mines of different countries. France does not altogether produce more than 8000 marcs of silver annually; and yet there are veins in that country (those of *Sainte-Marie-aux-Mines*) from which amorphous masses of native silver have been extracted, of the weight of 30 kilogrammes. *

It appears that at the period of the formation of veins in every climate, the distribution of

* 66lb. avoird. *Trans.*

silver has been very unequal; sometimes concentrated in one point, and at other times disseminated in the *gangue*, and allied with other metals. Sometimes in the midst of the poorest ores we find very considerable masses of native silver; a phenomenon which appears to depend on a particular operation of chemical affinities, the mode of action and laws of which we are completely ignorant of. The silver instead of being concealed in galena, or in pyrites in a small degree argentiferous, or of being distributed throughout all the *mass of the vein* over a great extent, is collected into a single mass. In that case the riches of a point may be considered as the principal cause of the poverty of the neighbouring ores; and hence we may conceive why the richest parts of a vein are found separated from one another by portions of *gangue* almost altogether destitute of metals. In Mexico, as well as in Hungary, large masses of native silver and *glaserz*, appear only in nests or kidneys, (*par rognons;*) and the compound rocks exhibit the same phenomena as the *masses* of veins. When we examine with care the structure of granites, syenites, and porphyries, we discover the effects of a particular attraction in the crystals of Mica, amphibole and feldspar, of which a great number are accumulated in

one point, while the neighbouring parts are almost entirely destitute of them.

Although the New Continent, however, has not hitherto exhibited native silver in such considerable blocks as the Old, this metal is found more abundantly in a state of perfect purity in Peru and Mexico, than in any other quarter of the globe. In laying down this opinion, I am not considering the native silver which appears in the form of lamellæ, branches, or cylindrical filaments in the mines of Guantahajo, Potosi, and Gualgayoc, or in Batopilas, Zacatecas, and Ramos. I found my opinion rather on the enormous abundance of the ores called *pacos* and *colorados*, in which silver is not *mineralised*, but disseminated in such small particles, that they can only be perceived by means of a microscope.

The result of the investigations made by Don Fausto d'Elhuyar, the director general of the mines of Mexico, and by several members of the superior council of mines, is, that in uniting together all the silver minerals annually extracted, it would be found from the mixture, that their mean produce is from 0.0018 to 0.0025 of silver, that is to say in the common language of miners, that a *quintal of ore* (of one hundred pounds, or 16,000 ounces) *contains from three to four ounces of silver*. This important result is confirmed by the testimony of an inhabitant of Zacatecas, who dad the direction of considerable metallic operations, in several districts of mines of New Spain, and who has lately published a very interesting work, on the American amalgamation. M. Garces*, whom we have already had occasion to quote, expressly says, "that the great mass of Mexican "ores is so poor, that the three millions of marcs "of silver annually produced by the kingdom "in good years, are extracted from ten millions "of quintals of mineral, partly smelted, and "partly amalgamated." According to these numbers, the mean riches would only amount to $2\frac{1}{3}$ ounces per quintal, a result which differs very much from the assertion of a traveller, very estimable in other respects†, who relates that the veins of New Spain are of such extraordinary wealth, that the natives never think of working them when the minerals contain less than a third of their weight in silver, or seventy marcs per quintal. As the most erroneous ideas have

* *Nueva Theorica del beneficio de los metales, por Don Joseph Garces y Eguia, Perito facultativo de minas y primario de beneficios de la mineria de Zacatecas* (Mexico, 1802,) p. 121 & 125.

† The Jesuit *Och* (*Murrs Nachrichten vom Spanischen America*, t. i. p. 236.)

been spread through Europe respecting the *contents* of the ores of America, I shall proceed to give a more minute description of the districts of mines of Guanaxuato, Tasco, and Pachuca, which I had occasion to visit.

At Guanaxuato, the mine of the Count de la Valenciana produced between the 1st January, 1787, and the 11th June, 1791, the sum of 1,737,052 marcs of silver, which were extracted from 84,368 *montones* of ores. In the table * containing the general state of the mine, a *monton* is estimated at 32 quintals, or at $9\frac{4}{100}$ *cargas;* from whence it follows that the mean riches of the minerals was, twenty years ago, $5\frac{1}{100}$ ounces of silver per quintal. Applying the same calculation to the produce of the single year 1791, we shall find $9\frac{3}{100}$ ounces per quintal.

* *Estado de la mina Valenciana, remitido por mano del Excellentiss. Señor virey de Nueva España al Secretario de Estado Don Antonio Valdes.* (Manuscript.) I have followed the numbers contained in the table drawn up by Don Joseph Quixano, the administrator of the Valenciana. A *monton* (a heap of ores reduced to powder) is reckoned at 35 quintals at Guanaxuato; at thirty at the Real del Monte, Pachuca, Zultepeque, and Tasco; at Zacatecas and Sombrerete, at 20; at Fresnillo at 18; and at 15 quintals at Bolaños. The *carga* is generally estimated at Guanaxuato at 14 *arrobas;* so that 10 cargas amount there to a *monton* (*Garces*, p. 92.) As the wealth of the ore is determined from the *contents of the monton*, the exact knowledge of the measure is of great importance in metallurgical calculations.

At this period, when the mine was in the most flourishing condition, in the total mass of ores there were:

	Mar.	Oss.
$\frac{5}{100}$ of rich ores (*polvillos* and *Xabones*,) containing per quintal	22	3
$\frac{28}{100}$ of rich ores (*apolvillado*)	9	3
$\frac{157}{100}$ of rich ores (*blanco bueno*)	3	1
$\frac{816}{100}$ of poor ores (*granzas, tierras ordinarias, &c.*)		3

The quantity of rich ores, was consequently to that of the poor ores, nearly in the proportion of 3 to 14. The ores which only contained 3 ounces per quintal, supplied in 1791 (we are always speaking of the Valenciana mine alone) more than 200,000 marcs of silver, while there was a sufficient quantity of rich ores, (from 3 to 22 marcs per quintal) to yield a produce of more than 400,000 marcs. At present, the *mean* richness of the whole vein of Guanaxuato may be estimated at 4 ounces of silver per quintal of ores. The South West part of the vein, which intersects the mine of Rayas, yields, however, minerals, of which the *contents* generally amount to more than 3 marcs.

In the district of the mines of Pachuca, they divide the produce of the seam of Biscaina into three classes, of which the richness varied

in 1803, from 4 to 20 marcs per *monton* of 30 quintals. The minerals of the first class which are the richest, contain from 18 to 20; and those of the second class from seven to ten marcs. The poorest mines which form the third class are only computed at four marcs of silver per *monton*. The result is that the *good* contains from $4\frac{8}{10}$ to $5\frac{3}{10}$; the *middling*, from $1\frac{8}{10}$ to $2\frac{7}{10}$; and the *worst* about $1\frac{3}{5}$ ounces of silver per quintal.

In the district of mines of Tasco, the minerals of Tehuilotepec contain in a *tarea* of four *montones* or 100 quintals, 25 marcs of silver; those of Guautla yield 45; their mean wealth is consequently from 2 to $3\frac{6}{10}$ ounces of silver per quintal of minerals.

It is not then, as has been too long believed, from the intrinsic richness of the ores, but rather from the great abundance in which they are found in the bowels of the earth, and the facility with which they can be wrought, that the mines of America are to be distinguished from those of Europe*. The three

* The silver ores of Peru do not in general appear to be richer than those of Mexico: The *contents* are estimated not by the *monton*, but by the *caxon* (chest) which contains 24 cargas, reckoning each carga at ten *arrobas* or $2\frac{1}{2}$ quintals. At *Potosi*, the *mean* richness of the minerals is $\frac{5}{10}\frac{5}{0}$; in the mines of Pasco, $1\frac{3}{5}$ ounces per quintal.

districts of mines which we have just alluded to, furnish alone, more than a million of marcs of silver, and from the whole of these data we cannot entertain a doubt that the *mean contents* of the Mexican ores do not amount, as we have already stated, to more than from three to four ounces of silver, per quintal. Hence these ores, though somewhat richer than those of Freiberg, contain much less silver than the ores of Annaberg, Johann-Georgenstadt, Marienberg, and other districts of the *Obergebirge* in Saxony. From 1789 to 1799, their have been extracted *communibus annis* from the mines of the district of Freiberg, 156,752 quintals, which have yielded 48,952 marcs of silver; so that the mean contents were $2\frac{3}{8}\frac{9}{0}$ ounces per quintal of minerals. But in the mines of the *Obergebirge* the mean riches have amounted to ten, and at very fortunate periods even to fifteen ounces per quintal.

We have taken a general view of the rocks in which the principal mines of New Spain are found; we have examined on what points, in what latitudes, and at what elevations above the level of the sea, nature has collected the greatest quantity of metallic wealth; and we have indicated the ores which furnish the immense quantity of silver which annually flows from the one continent to the other. It remains for us to afford some details relative to the most con-

siderable mining operations. We shall confine ourselves to three of these *groups of mines* which we have already described, to the central group, and those of Tasco and Biscaina. Those who know the state of mining in Europe will be struck with the contrast between the great mines of Mexico, for example those of the Valenciana, Rayas, and Tereros, and the mines which are considered as very rich in Saxony, the Harz, and Hungary. Could the latter be transported to the midst of the great works of Guanaxuato, Catorce, or the Real del Monte, their wealth and the quantity of their produce, would appear as insignificant to the inhabitants of America, as the height of the Pyrenees compared with the Cordilleras.

The *Central group* of the mines of New Spain, a portion of ground abounding more in silver than any other known on the globe, is situated in the same parallel with Bengal, under a latitude where the equinoctial is confounded with the temperate zone. This group comprehends the three mining districts of Guanaxuato, Catorce, and Zacatecas, the first of which possesses an extent of 220, the second of 750, and the third of 730 square leagues, calculating the surfaces from the position of the insulated mines (*realitos*) at the greatest distance from the chief place of the district.

The *district of Guanaxuato*, the most southern

of this group, is as remarkable for its natural wealth as for the gigantic labours of man in the bowels of the mountains. To form a more exact idea of the position of these mines, we invite the reader to call to mind what we have already stated * in the particular description of the provinces, and to cast his eyes over the physical section of the central table land, in the atlas to this work.

In the centre of the intendancy of Guanaxuato on the ridge of the cordillera of Anahuac, rises a group of porphyritic summits known by the name of the Sierra de Santa Rosa. This group of mountains partly arid, and partly covered with strawberry-trees and evergreen oaks, is surrounded with fertile and well cultivated fields. To the north of the *Sierra*, the *Llanos* of San Felipe extend as far as the eye can reach; and to the South, the plains of Irapuato and Salamanca exhibit the delightful spectacle of a rich and populous country. The *Cierro de los Llanitos*, and the *Puerto de Santa Rosa*, are the most elevated summits of this

* Vol. ii. p. 204. I have drawn up a geographical map of the environs of the town of Guanaxuato, which will appear in the historical account of my travels in the Equinoctial Regions of America. This map is partly taken from the *perpendicular bases* measured barometrically. See Vol. i. Introduction, p. xiii. and my *Recueil d'Observations Astronomiques*, Vol. i. p. 372.

group of mountains. Their absolute height is from 2,800 to 2,900 metres *, but as the neighbouring plains which are part of the great central table land of Mexico, are more than 1800 metres † above the level of the sea, these porphyritic summits appear but as inconsiderable hills to the eyes of a traveller accustomed to the striking appearance of the Cordilleras. The famous vein of Guanaxuato, which has alone, since the end of the sixteenth century, produced a mass of silver equal to fourteen hundred millions of francs ‡, crosses the southern slope of the Sierra de Santa Rosa.

In going from Salamanca to Burras and Temascntio, we perceive a chain of mountains, which bounding the plains, stretches from the South-east to the North-west. The crest of the vein follows this direction. At the foot of the Sierra, after passing the farm of Xalapita, we discover a narrow ravin dangerous to pass at the period of the great swells, called the *Canada de Marfil*, which leads to the town of Guanaxuato. The population of that town, as we have already observed, is more than 70,000 souls. One is astonished to see in this wild spot, large and

* From 8985 to 9313 feet. *Trans.*

† 5904 feet. *Trans.*

‡ £ 57,754,620 Sterl. *Trans.*

beautiful edifices in the midst of miserable Indian huts. The house of Colonel Don Diego Rul, who is one of the proprietors of the Valenciana mine, would be an ornament to the finest streets of Paris and Naples. It is fronted with columns of the Ionic order, and the architecture is simple and remarkable for great purity of style. The erection of this edifice, which is almost uninhabited, cost more than 800,000 francs *, a considerable sum in a country where the price of labour and materials are very moderate.

The name of Guanaxuato is scarely known in Europe; and yet the riches of the mines of this district are much superior to that of the *metalliferous depository* of Potosi. The latter was discovered in 1545 by Diego Hualca an Indian, and has produced, according to information † never yet made public, in the space of two hundred and thirty-three years,, 788,258,512 double piastres, which reckoning eight piastres

* £33,000, Sterl. *Trans.*

† *Extract from a book of accounts of the Royal Treasury of Potosi, made on the spot, by Mr. Frederic Mothes (Razon de los reales derechos que se han cobrado en las caxas reales, de la plata que ha producido el Cerro de Potosi).* This manuscript memoir in my possession gives the produce of Potosi every year from 1558 to 1789. The treasury books contain no information relative to the years anterior to 1556, although two miners of Porco, Juan de Villaroel and Diego Centeno, began to work this vein in the year 1545.

and a half to the marc, gives the sum of 92,736,294 marcs of silver *, viz.

	Piastres.		Marcs of silver.
From 1556 to 1578—	49,011,285	or	5,766,033
1579 to 1736—	611,399,451	—	71,929,347
1737 to 1789—	127,847,776	—	15,040,914
	788,259,512		92,736,294

During these three periods then, there has been extracted from the Cerro de Potosi annually at an average,

	Marcs of silver.		Piastres.
From 1556 to 1578	— 262,092 †	or	2,227,782
1579 to 1736	— 458,148 ‡	—	3,994,258
1737 to 1789	— 289,248 §	—	2,458,606

The produce of the vein of Guanaxuato, however, is almost the double of that of the Cerro de Potosi. There is actually drawn from this vein (for it alone furnishes all the silver of the mines of the district of Guanaxuato) in average years from *five to six hundred thousand marcs of silver, and from fifteen to sixteen hundred marcs of gold.*

* 60,864,359 lb. Troy. *Trans.*
† 172,015 lb. Troy. *Trans.*
‡ 300,524 lb. Troy. *Trans.*
§ 189,837 lb. Troy. *Trans.*

Gold Produce of the District of Mines of Guanaxuato.

Periods.	Gold extracted by Amalgamation.			Gold extracted by Smelting.		
	Castellanos.	Tomines.	Granos	Castellanos.	Tomines.	Granos.
1766	702	3	9	35542	4	0
1767	552	0	0	46325	4	10
1768	0	0	0	40130	0	0
1769	0	0	0	31543	0	0
1770	5361	6	8	46945	0	0
1771	7938	3	8	47980	0	3
1772	7759	2	2	50917	3	8
1773	5135	4	0	35662	0	0
1774	1985	5	9	30835	5	1
1775	6235	4	8	50671	7	0
1776	22527	4	0	81642	4	4
1777	21673	6	3	74481	3	3
1778	23034	6	8	50100	6	3
1779	31115	2	3	50636	3	5
1780	25044	0	0	29123	4	1
1781	30790	2	6	27781	0	1
1782	24645	2	10	15975	7	8
1783	32887	3	4	20830	0	7
1784	28332	4	10	25194	3	1
1785	26823	2	4	20012	0	5
1786	25217	0	5	12275	5	4
1787	21820	0	2	13124	5	4
1788	13160	7	4	10374	2	9
1789	16451	5	4	16927	0	10
1790	21219	2	2	13135	4	9
1791	25654	6	7	23407	5	0
1792	16855	3	1	8434	5	0
1793	28257	2	10	16360	1	4
1794	23090	1	0	7084	2	1
1795	31518	1	0	24441	5	7
1796	43538	5	6	10505	7	7
1797	34454	0	0	13962	6	3
1798	92074	6	9	34393	7	5
1799	67332	1	4	31316	6	7
1800	71791	2	4	24833	6	9
1801	49305	0	8	31579	5	6
1802	46459	0	4	40401	1	2
1803	59772	1	1	17100	2	8

Silver Produce of the District of Mines of Guanaxuato.

Periods.	Silver extracted by Amalgamation.		Silver extracted by Smelting.			
	Marcs.	Ounces.	Marcs.	Ounces.	Tomines.	Granos.
1766	207412	5	86407	1	0	0
1767	185439	2	77847	3	0	0
1768	194579	4	87906	0	1	8
1769	194628	2	106444	3	3	11
1770	233235	6	123782	0	6	0
1771	299016	1	120845	2	5	11
1772	287160	7	96412	0	7	0
1773	267621	7	136799	4	4	1
1774	243601	4	98957	0	3	2
1775	277589	7	96727	7	5	5
1776	434175	7	164756	1	7	1
1777	452226	4	169991	0	1	1
1778	431850	5	93152	5	0	5
1779	418215	2	118200	5	0	9
1780	338470	4	138820	1	1	2
1781	403772	7	162184	0	7	0
1782	309734	1	148302	4	1	2
1783	430957	5	113145	3	2	1
1784	386861	7	100319	3	2	0
1785	365308	2	100836	5	3	1
1786	316332	5	96300	7	6	4
1787	365038	3	103223	3	0	3
1788	403894	3	93657	1	5	7
1789	487321	6	137120	2	4	7
1790	463807	6	131318	0	4	8
1791	623921	5	143685	5	7	3
1792	541735	6	93711	6	4	1
1793	440581	4	76035	3	1	8
1794	443366	3	81206	3	3	4
1795	462444	5	104652	6	1	0
1796	404639	2	84486	7	6	6
1797	592512	1	114540	2	6	10
1798	521888	4	104048	5	3	3
1799	406286	5	93679	4	2	5
1800	397119	4	109557	0	7	2
1801	221590	1	118860	1	7	0
1802	319719	0	177460	1	4	0
1803	659992	7	84172	4	7	0

I have specified in these tables, year after year, the gold and silver extracted from the mines of Guanaxuato from 1766 to 1803; and I have distinguished the metals procured from the ores by means of amalgamation, from those obtained by smelting. A marc of gold contains 50 *castellanos*, which are equal to 400 *tomines*, or 4800 *granos*. The result of these tables, which are framed from official papers *, is that the district of mines of Guanaxuato has produced in 38 years gold and silver to the value of 165 millions of piastres †; and that from 1786 to 1803, the annual average produce has been 556,000 marcs of silver ‡, equal to 4,727,000 piastres. All the veins of Hungary and Transylvania together, only yield 85,000 marcs of silver. §

Taking four averages of years, of which three are of five and one of eight years, we shall have the following results:

* *Razon de los Castellanos de oro de ley* 22 *quilates y marcos de plata, de* 12 *dineros de los beneficios de Azogue y Fuego, manifestados en la tresoreria principal de Real Hacienda de Guanaxuato, desde* 1° *de Enero* 1766 *hasta* 31 *de Diciembre* 1803. (Manuscript.) We have computed the marc of silver at 8½ piastres, and the marc of gold at 136 piastres (the piastre being equal to 5 livres 5 sous).

† 12,720,061 lb. Troy. *Trans.*

‡ 364,911 lb. Troy. *Trans.*

§ 55,686 lb. Troy. *Trans.*

Periods.	Value of the total produce of gold and silver extracted from the mines of Guanaxuato.	Silver for an average year.	Value of gold and silver for an average year.
	Piastres.	Marcs.	Piastres.
1766—1775	30,320,503	342,241	3,032,050
1776—1785	46,692,863	528,121	4,669,286
1786—1795	48,682,662	560,936	4,868,266
1796—1803	39,306,117	551,319	4,913,265

What is the nature of the *metalliferous depository*, which has furnished these immense riches; and which may be considered as the Potosi of the northern hemisphere. What is the position of the rock which crosses the veins of Guanaxuato? These questions are of so great importance that I must here give a geological view of so remarkable a country.

The most ancient rock known in the district of Guanaxuato, is *clay slate* (*thon-schiefer*) which rests on the granite rocks of Zacatecas and the Peñon Blanco. * It is of an ash-grey or greyish black color, frequently intersected † by an infinity of small quartz veins, and at a considerable depth passes into talk-slate (*talk-schiefer*) and into *schistous chlorite*. I consider this *clay-slate* as of primitive formation, although

* *Sonneschmidt, Beschreibung der Bergwerks-Refiere von Mexico*, p. 194 & 292.

† In the *quebrada* of San Roquito, which communicates with the ravin of Acabuca.

the beds with very thin folia which it contains, and which are surcharged with carbon, appear to approximate it to *transition clay slate*. These beds (*oja de libro*) are for the most part found near the surface *; but sometimes they are visible † at considerable depths. On digging the great pit (*tiro general*) of the Valenciana, they discovered banks of *syenite*, of *hornblend slate* (*hornblend schiefer*) and true *serpentine*, alternating with one another, and ferming *subordinate beds*, in the *clay slate*. This extraordinary phenomenon of a syenite alternating with serpentine, is also to be seen in the island of Cuba, near the village of Regla, where the latter rock abounds in *schillerspar* (*schillerspath*). The same *clay slate* of Guanaxuato which is observed at the bottom of the mine of Valenciana, re-appears at the surface, eight hundred metres ‡ higher up on the ridge of the Sierra de Santa Rosa, but I doubt whether it has ever been found at greater elevations. These strata are very regularly *directed* h. 8 to 9. of the miner's compass §; they are inclined from 45 to 50

* In the Valenciana mine.

† In the mines of Mellado, Animas and Rayas.

‡ 2624 feet. *Trans.*

§ Or from South-East to North-West. I have been struck ever since 1791, with this great law of the *parallelism of the strata*, which are discovered in immense extents of country, and which may be regarded as one of the most curious pheno-

degrees to the south-west. This is the direction of the greatest part of the very old rocks of Mexico.

Two very different formations rest on the *clay slate*: the one of porphyry at considerable elevations to the east of the valley of Marfil, and to the north-west of Valenciana; and the other, of *old sandstone* in the ravins, and table lands of small elevation.

Porphyry forms gigantic stony masses, which appear at a distance, under the strangest aspect, frequently like ruins of walls and bastions. These masses are perpendicular, and from three to four hundred metres *, elevated above the

mena of geology. I have never ceased in my writings from calling the attention of travellers to an object, with regard to which it would be easy to collect in a very short time a great number of observations. See my *experiments on the irritation of the muscular and nervous fibre*, (in German) vol. i. p. 8; my *letter to M. de Fourcroy, dated 5 Pluviose* an 6; my *Tableau géologique de l'Amérique Méridionale* (Journal de Physique 1800); and my *Géographie des Plantes*, p. 117. The direction of high chains of mountains appears to have the greatest influence on the direction of the beds, even at considerable distances from the central crest. This influence is manifest in the Pyrenees, Mexico, and especially in the Upper Alps. See the judicious observations which M. Ebel, a learned mineralogist has published on this subject under the title of, *On the Construction of the Chain of the Alps* (in German) vol. i. p. 220; vol. ii. p. 201 — 215. & p. 357.

* From 984 to 1314 feet. *Trans.*

surrounding plains. In the country they go by the name of *Buffa*. Enormous balls with concentrical layers rest on insulated rocks. These porphyries give a savage character to the environs of Guanaxuato, calculated to astonish the European traveller, who imagines that nature never deposits great metallick wealth but in mountains with round tops, and in places where the surface has a gentle and uniform undulation. This porphyry of which the *Sierra de Santa Rosa* is chiefly composed, is generally of a greenish colour; but it varies very much according to the nature of its base, and the crystals which it contains. The oldest beds appear to be those of which the base is hornstone * (*hornstein*) or *compact felspar*. The most recent on the other hand, contain vitreous felspar, imbedded in a mass which sometimes passes into jade, and sometimes into the phonolite or *klingstein* of Werner. The latter bear the

* Being a pupil of Werner, and of the school of Freiberg, I every where name in my works *Hornstein* a mineral which forms transitions into quartz, calcedony, and flint (*feuerstein*). The *hornsteine* of the German mineralogists are, the *Quartz-agathes, grossier et xyloïdes* of M. Haüy, the *néopètres* of Saussure, and the *silex cornés* of M. Brogniart. This note appeared to me indispensable, on account of the confused synonomy of the denominations *petrosilex, pierre de corne*, and *roche de corne*.

greatest analogy to the porphyry slate (*porphyr-schiefer*) of the *mittelgebirge* of Bohemia. One would be tempted to reckon them among the rocks of *trapp-formation*, if these same beds did not contain at Villalpando the richest mines of gold. All the porphyries of the district of Guanaxuato possess this in common, that hornblende is almost as rare in them as quartz and mica. The *direction* and *inclination* of their strata are the same as those of the clay slate.

On the southern slope of *la sierra*, and generally at smaller elevations than that at which porphyry appears in the plains of Barras and Cuevas, especially between Marfil, Guanaxuato, and Valenciana, the *clay-slate* is covered with *sand-stone* of an old formation. This sand-stone (*urfels-conglomerat*) is a breccia with argillaceous cement, mixed with oxide of iron, in which are imbedded *angular fragments* of quartz, Lydian stone, syenite, porphyry, and splintery hornstone. Beds containing from six to eight centimetres * in thickness alternate sometimes (near Cuevas) with other beds, in which grains of quartz are conglutinated by an ochry cement. At other times (in the ravin of Marfil and

* From 2 to 3 inches. *Trans.*

in the road of Salgado) the cement becomes so abundant that the imbedded fragments entirely disappear, and banks of slate-clay of a yellowish brown, from eight to nine metres in thickness * alternate with breccia, composed of large flints. This old sand-stone formation is the same with that which appears at the surface in the plains of the Amazon river, in South America, and which, in Switzerland, rises to more than a thousand metres † of absolute height, in the Oltenhorn and the Diablerets, has no regularity in the direction of its beds. Their inclination is generally the reverse of that of the *strata* of *clay slate*. Near Guanaxuato, the sand-stone formation overlays the porphyry of the Buffa; but near Villalpando the porphyry itself serves for base to the old breccia, which appears at the surface at an absolute height of 2600 metres. ‡

We must not confound the breccia which contains imbedded fragments of primitive and transition rock, with another mass which may be designated by the name of *felspar conglomerate*, and which, at the mountain of *la Cruz de Serena*, overlays the old

* From 26 to 29 feet. *Trans.*
† 9842 feet. *Trans.*
‡ 8529 feet. *Trans.*

breccia (*urfels conglomerat*), and is consequently of a more recent formation. This conglomerate (*lozero*) which yields the finest building-stone, is composed of grains of quartz, small fragments of slate, and felspar crystals, partly broken, and partly in a perfect state. These substances are connected together by an argillo-ferruginous cement. Probably the destruction of porphyries has had the greatest influence on the formation of this feldspatic sand-stone. It contrasts with the free-stone of the Old Continent, in which some crystals of garnets and amphibole have been found, but never, as far as I know, felspar in any abundance. The most experienced mineralogist, after examining the position of the *lozero* of Guanaxuato, would be tempted to take it at first view, for a porphyry with clayey base, or for a porphyritic breccia (*trümmer-porphyr*). Near Villalpando, about thirty very thin banks of *slate clay* (*schiefer-thon*) of a blackish brown colour, alternate with the feldspar conglomerate.

This old sand-stone formation of Guanaxuato, serves as a basis to other secondary beds, which in their *position*, that is to say in *the order of their superposition*, exhibit the greatest analogy with the secondary rocks of central Europe. In the plains of Temascatio (at *lo de Sierra*) there is a compact lime-

stone (*dichter kalkstein*) frequently full of vesicular cavities, which are coated with calcareous spar, and oxide of manganese, both earthy and radiated. This rock which, in its *even* and almost *conchoidal fracture*, resembles the *Jura lime-stone*, is covered in some points with banks of fibrous gypsum mixed with hardened clay.

We have thus enumerated the various rocks which rest on the *clay slate* of Guanaxuato, and which are on the one hand secondary formations of sandstone, limestone, and gypsum; and on the other, formations of porphyry, syenite, serpentine and hornblende slate. The ravin of Marfil, which leads from the plains of Burras to the town of Guanaxuato, separates as it were the porphyritic region from that in which *syenite* and *greenstone* predominate. To the east of the ravin, very steep prophyry mountains exhibit the most whimsical forms from the manner in which they are torn asunder; and to the westward we see a district of which the gently undulated surface is covered with basaltic cones.

From the mine of Esperanza, situated to the north-west of Guanaxuato, to the village of Comangillas, celebrated for its hot springs, the *clay slate*, to the extent of more than twenty square leagues, serves for a base to beds of syenite which alternate with *transition*

greenstone (*diabase*). These beds are in general from four to five decimeters* in thickness; and they are inclined by groups, sometimes to the north-east, sometimes to the west, and always at angles of from 50 to 60 degrees. In travelling from Valenciana to Ovexeras, we see several thousands of these banks of *greenstone*, alternating with a syenite, in which quartz is sometimes in greater abundance than felspar and hornblende. We find veins of greenstone in this syenite, and crevices filled with syenite in the beds of *greenstone*. This identity of the *mass* of the veins with the superimposed rocks, is a curious fact which seems to favour the theory of the origin of veins, laid down by Mr. Werner.† Near Chichimequillo, a columnar porphyry seems to rest on syenite. It is covered with basalt and basaltic breccia, from which the springs, of which the temperature is 96° 3‡ of the centrigrade thermometer, have their source.

It remains for me to give an account of two *partial formations* which occupy only a very small extent: a *compact limestone* (*elcaliche*) of a blackish grey color, belonging perhaps to

* From 15 to 19 inches. *Trans.*

† *Neue Theorie von der Entstehung der Gänge*, 1791, p. 60.

‡ 205° of Fahrenheit. *Trans.*

*transition rocks**, and a calcareous breccia (*frijollilo*). The latter, which I saw in the mine of Animas, at a depth of more than 150 metres†, is composed of round fragments of compact limestone, connected together by a calcareous cement. The *clay slate* of Valenciana serves for base to these two partial formations, one of which appears to owe its origin to the destruction of the other.

Such is, according to the observations made by me on the spot, the *geological constitution* of the country at Guanaxuato. The vein (*veta madre*) traverses clay slate as well as porphyry; and in both of these rocks it has proved very rich in ore. Its mean direction is h. 8½ of the miner's compass‡; and is nearly the same with that of the *veta grande* of Zacatecas, and of the veins of Tasco and Moran, which are all western veins (*spathgänge*). The inclination of the vein of Guanaxuato, is 45 or 48 degrees to the south-west. We have already stated, that it has been wrought for a length of more than 12,000 metres; and yet the enormous mass of silver which it has supplied for the last hundred years, sufficient of itself to produce a

* Between the ravins of Sechò and Acabuca, the banks of the *caliche* have the same direction and the same inclination as the strata of *clay slate*.

† 492 feet. *Trans.*

‡ Or N 52°. W.

change in the price of commodities in Europe, has been extracted from that part of the vein alone contained between the pits of Esperanza and Santa Anita, an extent of less than 2600 metres.* In this part we find the mines of Valenciana, Tepeyac, Cata, San Lorenzo, Animas, Mellado, Fraustros, Rayas, and Santa Anita, which at different periods have been very highly celebrated.

The *veta madre* of Guanaxuato, bears a good deal of resemblance to the celebrated Spital vein of Schemnitz, in Hungary. The European miners, who have had occasion to examine both these *depositories* of minerals, have been in doubt whether to consider them as true veins, or as *metalliferous beds* (*erz-lager*). If we examine the *veta madre* of Guanaxuato only, in the mines of Valenciana or Rayas, where the *roof* and the *wall* are of *clay slate*, we might be tempted to acquiesce in the latter opinion; for far from *cutting* or *crossing* the *strata* of the rock (*quergestein*), the *veta* has exactly the same direction and the same inclination as its *strata*; but can a *metalliferous bed* which has been formed at the same period as the whole mass of the mountain in which it is to be found, pass from a superior to an inferior rock, from porphyry to clay slate? If the *veta madre* were really a *bed*,

* 8529 feet. *Trans.*

we should not find *angular fragments* of its *roof* contained in its *mass*, as we generally observe on points where the *roof* is *slate* charged with *carbon*, and the wall a talc slate. In a vein, the *roof* and the *wall* are deemed anterior to the formation of the *crevice*, and to the minerals which have successively filled it; but a *bed* has undoubtedly pre-existed to the *strata* of the rock which compose its *roof*. Hence we may discover in a bed fragments of the *wall*, but never pieces detached from the *roof*.

The *veta madre* of Guanaxuato, exhibits the extraordinary example of * a crevice formed according to the direction and inclination of the strata of the rock. Towards the south-east from the ravin of Serena, or from the mines of Belgrado and San Bruno, which are very fully wrought, to beyond the mines of Marisanchez, it *runs through* porphyritic mountains; and towards the north-east, from the shafts of Guanaxuato, to the Cerro de Buena Vista and the Cañada de la Virgen, it traverses clay slate (*thon schiefer*). Its magnitude varies like that of all the veins of Europe.

* M. Werner in the Theory of Veins, § 2. expressly says, "that the depositories of minerals *almost always* cut the "banks of the rock." This great mineralogist seems to have intended to indicate by these words, that there may be true veins parallel to the folia of *argillaceous, or micaceous slate.*

When not ramified it is generally from 12 to 15 metres * in breadth; sometimes it is even contracted † to the width of half a metre ‡; and it is for the most part found divided into three masses, (*cuerpos*) separated either by banks of rock (*caballos*), or by parts of the gangue almost destitute of metals. In the mine of Valenciana the *veta madre* has been found without ramification, and of the breadth of 7 metres §, from the surface of the ground to the depth of 170 metres. ‖ At this point it divides into three branches, and its extent, reckoning from the *wall* to the *roof* of the *entire mass*, is 50 and sometimes even 60 metres. ¶ Of these three branches of vein, there is in general but one alone which is rich in metals; and sometimes when all the three *join* and *drag* one another, as at Valenciana near the pit of San Antonio, at a depth of 300 metres **, the vein contains immense riches on an extent (*puissance*) of more than 25 metres. †† In the *pertinencia de Santa Leocadia*, four branches are observable.

* From 38 to 48 feet. *Trans.*

† At the *place of assemblage* of the pit of *Santo Christa de Burgos*, in the Mine of Valenciana.

‡ 19 inches. *Trans.*

§ 22 feet. *Trans.*

‖ 557 feet. *Trans.*

¶ 164 and 196 feet. *Trans.*

** 984 feet. *Trans.*

†† 81 feet. *Trans.*

A *trum*, of which the inclination is 65°, separates from the inferior branch, (*cuerpo baxo*) and cuts the folia of the rock of the *wall*. This phenomenon, and the great number of *druses*, abounding with amethyst crystals, I found in the mines of Rayas, which affect the most different directions, are sufficient to prove that the *veta madre* is a vein, and not a *bed*. Other proofs not less convincing might be drawn from the existence of a vein, (*veta del caliche*) wrought in the compact lime-stone of Animas, which is parallel to the principal vein of Guanaxuato, and has exhibited the same silver ores. Is this *identity of formation*, ever found between two metalliferous *beds*, which belong to rocks of very different *antiquity?*

The small ravins into which the valley of Marfil is divided, appear to have a decided influence on the richness of the *veta madre* of Guanaxuato, which has yielded the most metal where the direction of ravins, and the slope of the mountains, (*flaqueza del Cerro*) have been parallel to the direction and inclination of the vein. When we stand on the elevation of Mellado, near the shaft which was sunk in 1558, we observe that the *veta madre* is in general most abundant in ores towards the north-west, towards the mines of Cata and Valenciana; and that to the south-east towards Rayas and

Santa Anita, the produce has been at once richer, rarer, and more inconstant. Besides in this celebrated vein, there is a certain *middle region* which may be considered as a depository of great riches; for above and below this region, the ores have yielded an inconsiderable share of silver. At Valenciana the *rich ores* have been in the greatest abundance, between 100 and 340 metres* in depth below the mouth of the gallery. This abundance appeared at Rayas at the surface of the earth; but the gallery of Valenciana is pierced according to my measurements†, in a plain which is more than 156 metres‡ above the *level* (*galerie d'ecoulement*) of Rayas; which might lead us to believe that the depository of the great wealth of Guanaxuato is found in this part of the vein, between 2130 and 1890 metres of absolute height above the level of the ocean.§ The deepest works of the mine of Rayas, (*los planes*) have never yet reached the inferior limit of this middle region; while the bottom (*das tiefste*) of the mine of Valenciana, the gallery of San Bernardo has unfortunately passed this limit more than 70 metres‖. Hence

* Between 328 and 1115 feet. *Trans.*

† See my *Recueil d'Observations Astronomiques*, Vol. i. p. 324. No. 332—357.

‡ 511 feet. *Trans.*

§ Between 6987 and 6199 feet. *Trans.*

‖ 229 feet. *Trans.*

the mine of Rayas continues to furnish extremely rich ores, while at Valenciana they have endeavoured for some years to supply by the extraction of a greater quantity of ores the deficiency in their intrinsic value.

The mineral substances which constitute the *mass* of the vein of Guanaxuato, are *common quartz*, amethyst, *carbonate of lime*, pearl spar, splintery hornstone, *sulphuret of silver*, dendritic *native silver*, prismatic black silver, deep red silver, native gold, *argentiferous galena*, brown blende, spar iron, and *copper* and *iron pyrites*. We observe besides though much more rarely, crystallized *feldspar* (the rhomboidal quartz of the Mexican mineralogists) calcedony, small masses of spar-fluor, capillary quartz (*haarförmiger quartz*), grey copper ore (*fahlerz*) and columnar carbonate of lead. The absence of the sulphate of barytes and muriate of silver, distinguishes the *formation* of the vein of Guanaxuato from that of Sombrerete, Catorce, Fresnillo, and Zacatecas. Those mineralogists who are interested in the study of regular forms, find a great variety of crystals in the mines of Guanaxuato, and especially in the red and black sulphuret of silver, and in the calcareous spar, and the brown spar.*

* On the pearl spar of Guanaxuato, see *Klaproth's Beiträge*, B. iv. p. 128. This variety of *brown-spar* (*braun-spath*) exhibits microscopic crystals imbricated and collected in very

The abundance of waters which filtrate through the crevices of the rock and the gangue, vary very much in the different points of the vein. The mines of Animas and Valenciana are entirely dry, though the works of the latter occupy a horizontal extent of 1500, and a perpendicular depth of 500 metres.* Between these two mines, in which the miner is incommoded by the dust and extreme heat †, lie the mines of Cata and Tepeyac, which remain inundated, because they do not possess sufficient mechanical force to draw off the water. At Rayas, it is drawn off in a very expensive manner by means of *baritels a mulets*, placed in the interior of the *traverses*, and raising the water not by pumps, but by the action of *chapelets de caissons* of a very imperfect construction. One is astonished to see mines of such considerable wealth without any level ‡, while the neighbouring ravins of Cata and Marfil, and

thin prisms. The interlacing of these prisms, (*parillas*) is so regular that they constantly form equilateral triangles.

* 4920 aud 1640 feet. *Trans.*

† From 22° to 27° centigrade, (71° and 80°. Fahr. *Trans.*); the temperature of the exterior air being 17° (62° Fahr.)

‡ In the district of the mines of Freiberg, which however do not yield annually the seventh part of the money extracted from the single mine of Valenciana, they have executed two levels, of which the one is 63,213 metres, and the other 57,310 metres in length (207,390 and 188,023 feet. *Trans.*)

the plains of Tenascatio, which are lower than the *bottom* of Valenciana, appear to invite the miners to undertake works which would both serve to draw off the water, and to transport the ores to the place where they are smelted and amalgamated.

The *Valenciana* is almost the sole example of a mine, which for forty years has never yielded less to its proprietors than from two to three million of francs * of annual profit. It appears that the part of the vein extending from Tepeyac to the North-west, had not been much wrought towards the end of the 16th century. From that period the whole tract remained forsaken till 1760, when a Spaniard who went over very young to America, began to work this vein in one of the points which had till that time been believed destitute of metals (*emborascado*). M. Obregon † (the name of this Spaniard) was without fortune; but as he had the reputation of being a worthy man, he found friends who from time to time advanced him small sums to carry on his operations. In 1766, the works were already 89 metres in depth ‡, and yet the expences greatly surpassed the value of the metallic produce. With a passion for mining

* From 82,506*l.* to 123,759*l.* per annum. *Trans.*

† See vol. i. p. 226.

‡ 262 feet. *Trans.*

equal to what some display for gaming, M. Obregon preferred submitting to every sort of privation to the abandoning his undertaking. In the year 1767 he entered into partnership with a petty merchant of Rayas, of the name of Otero. Could he then hope that in the space of a few years, he and his friend would become the richest individuals in Mexico, perhaps in the whole world? In 1768 they began to extract a very considerable quantity of silver minerals from the mine of Valenciana. In proportion as the shafts grew deeper, they approached that region which we have already described as the depository of the great metallic wealth of Guanaxuato. In 1771 they drew from the *pertinencia de Dolores* enormous masses of sulphuret of silver, mixed with native and red silver. From that period till 1804, when I quitted New Spain, the mine of Valenciana has continually yielded an annual produce of more than 14 millions of livres tournois.* There have been years so productive, that the net profit of the two proprietors of the mine has amounted to the sum of six millions of francs.†

M. Obregon, better known by the name of Count de la Valenciana, preserved in the midst

* 583,380*l.* sterling. *Trans.*

† About 250,000*l.* sterling. *Trans.*

of immense wealth, the same simplicity of manners, and the same frankness of character, for which he was distinguished previous to his success. When he began to work the vein of Guanaxuato, above the ravin of San Xavier, goats were feeding on the very hill which ten years afterwards was covered with a town of seven or eight thousand inhabitants. Since the death of the old Count, and his friend Don Pedro Luciano Otero, the property of the mine has been divided among several families.* I knew at Guanaxuato two younger sons of M. Otero, each of whom possessed in ready money, a capital of six millions and a half†, without including the actual revenue from the mine, which amounted to more than 400,000 francs.‡

The constancy and equality of the produce of the mine of Valenciana, is so much the more surprising, as the abundance of the rich mines has considerably diminished, and the expences of working have increased in an alarming proportion, when the *works* have reached a perpendicular depth of 500 metres.§ The *piercing*

* The property of Valenciana is divided into twenty-eight shares, called *barres*, of which ten belong to the descendants of the Count de la Valenciana, twelve to the family of Otero, and two to that of Santana.

† 271,835*l.* Sterling. *Trans.*

‡ 16,600*l.* and upwards. *Trans.*

§ 1640 feet. *Trans.*

and *walling* of the three old *draught-pits* cost the Count de Valenciana nearly six millions of francs, viz.

	Piastres.
The square shaft of San Antonio or *tiro viejo*, 227 metres of perpendicular depth, and *four baritels a chevaux*	396,000
The square shaft of Santo Christo de Burgos, 150 metres in depth, and *two baritels a chevaux*	95,000
The hexagonal shaft of Nuestra Señora de Guadalupe (*tiro nuevo*) 345 metres in perpendicular depth, and *six baritels a chevaux*	700,000
Expence of the three shafts	1,191,000

Within these twelve years they have begun to dig in the solid rock, in the roof of the vein, a new *draught-pit* (*tiro general*), which will have the enormous perpendicular depth of 514 metres *, terminating at the actual *bottom* of the

* 1685 feet. *Trans.*

I reduce the *varas mexicanas* on the principle that a vara is equal to 0^m 839, or a toise = 2. 332 *varas mexicanas*. (See Vol. ii. p. 165.) In that country they consider the mines of Valenciana the deepest ever dug by man. At the period when I measured the *planes* of San Bernardo, the mine of Beschert Glück, at Freiberg in Saxony, had reached 447 metres of perpendicular depth. (1465 feet, Trans.) It is believed that

mine, or at the *planes of San Bernardo*. This shaft which will be in the centre of the works, will considerably diminish the number of the 980 miners (*tenateros*) employed as beasts of burden to carry the minerals to the upper *places of assemblage*. The *tiro general*, which will cost more than a million of piastres *, is octagonal, and contains 26^m. 8 of circumference. † Its walling is most beautiful. It is believed that they will reach the vein in 1815, although in the month of September 1803 the depth was not yet more than 184 metres. ‡ The piercing of this shaft is one of the greatest and boldest undertakings to be found in the history of mines. It may be questioned, however, whether for the sake of diminishing the expences of carriage and draught, it was expedient to recur to a remedy which is at once slow, expensive, and uncertain.

The expences of working the mine of Valenciana have been on an average annually:

	Piastres.
From 1787 to 1791 - - - -	410,000 §
From 1794 to 1802 - - - -	890,000 ‖

in the sixteenth century the works of the Saxon mines on the vein *Alter Thurmhof* went as far as 545 feet in depth. (1787 feet, *Trans.*) Author.

* 218,767*l.* Sterling. † 87 feet. *Trans.*

‡ 603 feet. *Trans.* § 89,694*l.* Sterling. *Trans.*

‖ 194,708*l.* Sterling.

Although the expences are doubled, the profits of the share-holders have remained nearly the same. The following table contains an exact state * of the mine for the last nine years.

* *Estado que manifiesta el valor de los frutos que ha producido la mina de Valenciana, costa de sus memorias y liquido producto, a favor de sus duenos; lo presentò Don Joseph Antonio del Maso, al Excellentissimo Señor Virey de Nueva España Don Joseph de Yturigarray, el* 3 *de Julio* 1803. (M. S.)

	PERIODS. 1794.	1795.	1796.	1797.	1798.	1799.	1800.	1801.	1802.	Total of the 9 years.
Produce of the sale of the minerals of Valenciana (in piastres).	1282042	1696640	1315424	2128439	1724437	1584393	1480933	1394338	1229631	13835380
Expences of working (in piastres).	799328	815817	832347	878789	890735	915438	977314	991981	944309	8046063
Net profit divided among the shareholders (in piastres).	482713	880822	483077	1249650	835702	668954	503619	401456	285321	5791317

The result of this table is, that the net profit of the share-holders has been latterly at an average of 640,000 piastres per annum.* In 1802 circumstances were extremely unfavourable. The greater part of the ores were very poor, and their extraction attended with great expence; and besides this, the produce was sold at very low prices, because the want of mercury impeded the amalgamation, and all the mines were incumbered with ores. The year 1803 promised greater advantages to the proprietors, and they reckoned on a net profit of more than half a million of piastres.† I saw them sell weekly at Valenciana, silver ores to the amount of more than 27,000 piastres: the expences amounted to 17,000. At Rayas, the profit of the proprietor was greater, though the produce was less; for this mine furnished more than 15,000 piastres of ores weekly, while the expence of working only amounted to 4000 piastres. This was the effect of the richness of the ores, their concentration in the vein, the inconsiderable depth of the mine, and consequently a less expensive *draught*.

* Above 3,360,000 livres tournois. (140,011*l.* sterling. *Trans.*) The profit distributed annually among the share-holders of the district of Freiberg only, amounts to 250,000 livres. (10,417*l.* Sterling. *Trans.*)

† 109,383*l.* Sterling. *Trans.*

To form an idea of the enormous advances required in working the mine of Valenciana, it is sufficient here to mention, that in its present state there must be laid out annually,

Livres.	
3,400,000	In wages of miners, triers, masons, and other workmen employed in the mine.
1,100,000	In powder, tallow, wood, leather, steel, and other materials necessary in mining.
Total expence 4,500,000 *	

The consumption of powder alone has amounted to 400,000 livres annually†; and that of the steel destined to the making of *pointroles* and *fleurets* to 150,000 livres.‡ The number of workmen who labour in the interior of the mine of Valenciana amounts to 1800. Adding 1300 individuals (men, women, and children) who labour at the *baritels a chevaux*, in the carriage of ores to the places where they are *tried*, we shall find three thousand one hundred individuals are employed in the different operations of the mine. The direction of the mine is entrusted to an administrator with a salary of 60,000§ francs, through whose hands upwards of six millions of francs annually pass. This

* 187,515*l.* Sterling. *Trans.*

† 16,668*l.* Sterling. *Trans.*

‡ 6250*l.* Sterling. *Trans.*

§ 2500*l.* Sterling. *Trans.*

administrator, who is under the controul of no one, has under his orders an overseer (*obersteiger, minero*), the under overseers (*untersteiger, sottomineros*), and nine *master miners* (*mandones*). These head people daily visit the subterraneous operations, carried by men * who have a sort of a saddle fastened on their backs, and who go by the name of little horses (*cavallitos*).

We shall conclude this account of the mine of Valenciana, with a comparative table of the state of this Mexican work, and of that of the celebrated mine of Himmelsfürst †, in the district of Freiberg. I flatter myself that this table will fix the attention of those who consider the study of the management of mines as an important object in political economy.

* For the extraordinary manner of travelling on men's backs, see my *Vues de Cordillères*. Pl. v.

† Whatever relates to this mine (in the following table) which I have frequently had occasion to visit in 1791, is taken from the work of *M. Daubuisson*, t. iii. p. 6—45.

Comparative table of the mines of America and Europe.

Average year at the end of the eighteenth century.	America. Mine of Valenciana; the richest of the Mexican Mines. At the surface, 2320 metres above the level of the sea.	Europe. Mine of Himmelsfürst, the richest of the Saxon Mines. At the surface, 410 metres above the level of the sea.
Metallic produce	360,000 marcs of silver	10,000 marcs of silver
Total expences of the mine	5,000,000 livres Tournois	240,000 livres Tournois
Net profit of the share-holders	3,000,000, livres	90,000 livres
The quintal of ores contains in silver	4 ounces	From 6 to 7 ounces silver
Number of workmen	3100 Indians and Mestizoes, 1800 of whom are in the interior of the mine	700 miners, of whom 550 are in the interior of the mine
Wages of the miners	From 4 to 6 livres Tournois	18 sous
Expence of powder	400,000 livres Tournois (nearly 1600 quintals)	27,000 livres Tournois (nearly 270 quintals)
Quantity of ores smelted and amalgamated	720,000 quintals	14,000 quintals
Veins	A vein frequently divides into thin *branches* of from 40 to 50 metres of extent (in clay slate)	Five principal veins, from two to three decimetres of extent (in *gneiss*)
Water	No water	Eight cubic feet per minute. Two hydraulic wheels
Depth of the mine	514 metres	330 metres

They reckoned in 1803 in the whole district of mines of Guanaxuato, five thousand miners and workmen employed in picking the ores, in smelting, and amalgamating; eighteen hundred and ninety-six *arastres*, or machines for reducing the ores into powder; and fourteen thousand six hundred and eighteen mules destined to move the baritels, and to tread, for amalgamation, the pulverized ores mixed with mercury. The *arastres* of the town of Guanaxuato bray, when there is an abundance of mercury, eleven thousand three hundred and seventy quintals of ores per day. If we recollect that the produce in silver is annually from 5 to 600,000 marcs, we shall find by this datum, that the *mean contents* of the ores are extremely small.

The celebrated mines of *Zacatecas*, which Robertson *, from what motive I know not, calls *Sacotecas*, are, as we have already observed, older than the mines of Guanaxuato. They began to be worked immediately after the veins of Tasco, Zultepeque, Tlapujahua, and Pachuca. They are situated on the central table land of the Cordilleras, which lowers rapidly towards New Biscay, and towards the basin of the Rio del Norte. The climate of Zacatecas, as well as that of Catorce is much colder than the climate

* *History of America*, vol. ii. p. 389.

of Guanaxuato and Mexico. Barometrical measurements will one day determine whether this difference is owing to a more northern position, or to the elevation of the mountains.

The nature of the former has been examined by two very intelligent mineralogists, M. M. Sonneschmidt * and Valencia, the one a Saxon, and the other a Mexican. From the whole of their observations it appears, that the district of mines of Zacatecas bears great resemblance in its geological constitution to that of Guanaxuato. The oldest rocks which appear *at the surface* are syenitic; they are overlaid by *clay slate*, which from the beds of Lydian stone, *grauwacke*, and *greenstone* which it contains, has a resemblance to *transition clay slate*. The most part of the veins of Zacatecas are found in this clay slate. The *veta grande*, or principal vein, has the same direction as the *veta madre* of Guanaxuato; the others are generally in a direction from east to west. † A porphyry destitute of metals, and forming those naked and perpendicular rocks which the natives call *buffas*, covers in many places the *clay slate*, especially

* *Beschreibung der Bergwerks-refiere von Mexico*, p. 166—237. *Descripcion geognostica del real de Zacatecas, por Don Vicente Valencia.* (M. S.)

† Sobre la formacion de las vetas, por Don Andres del Rios. (Gazeta de Mexico.) T. xi. n. 51.

on the side of the *Villa de Xeres*, where a mountain rises in the midst of these porphyritic formations, in the form of a bell, the basaltic cone of the *Campana de Xeres*. Among the secondary rocks of Zacatecas we observe, near the works of *la Sauceda*, *compact limestone*, in which Mr. Sonneschmidt also discovered Lydian stone, an old sandstone (*urfelsconglomerat*) containing fragments of granite *, and a *clayey* and *feldspar conglomerate* which is easily confounded with the *grauwacke* of the German mineralogists. The presence of the Lydian stone in limestone, might tempt us to believe that this last rock belongs to transition limestone (*übergangs kalkstein*) which appears at the surface in the *Cerro de la Tinaja*, eight leagues to the north of Zacatecas; but I must observe here, that on the coast of South America, near the Morro of New Barcelona, I found *flint-slate* forming subordinate beds in a limestone which is undoubtedly secondary.

The savage aspect of the metalliferous mountains of Zacatecas, forms a singular contrast to the great wealth of the veins which they contain. This wealth is displayed, and the fact is very remarkable, not in the ravins, and where the veins run along the gentle slope of the

* In the ravin leading from Zacatecas to the convent of Guadalupe.

mountains, but most frequently on the most elevated summits, on points where the surface appears to have been tumultuously torn, in the antient revolutions of the globe. The mines of Zacatecas produce yearly at an average, from 2500 to 3000 bars of silver, at 134 marcs each. *

The *mass* of the veins of this district † contains a great variety of minerals, viz.: *quartz*, *splintery hornstone*, calcareous spar, a little sulphate of barytes and *brown spar*; prismatic black silver, called in the country *azul acerado*; sulphuret of silver, (*azul plomilloso*) mixed with native silver; *black silver*, (the *silber-schwärtze* of the Germans, *polvorilla* of the Mexicans); pearl grey, blue, violet, and leek green muriate of silver, (*plata parda azul y verde*) at very inconsiderable depths; a little red silver, *pet-langue* or *rosicler*); and native gold, particularly to the south-west of the town of Zacatecas;

* From 219,866 to 263,839 lb. Troy. *Trans.*

† *Sonneschmidt*, p. 185. The minerals called by the inhabitants of Zacatecas *copalillo*, *metal cenizo*, and *metal azul de plàta*, appear to this mineralogist mixtures of galena, sulphuret of silver, and native silver. I have thought proper to insert these synonyms of the Mexican minerals, because their knowledge is very important to the mineralogical traveller. See *Garces*, *Nueva Theoria del beneficio de los metales*, p. 87, 124, and 138.

argentiferous sulphuret of lead (*soroche plomoso reluciente y tescatete*); carbonate of lead; black, brown, and yellow sulphuret of zinc, (*estoraque* and *ojo de vivora*); copper and iron pyrites (*bronze nochistle*, or *dorado*, and *bronze chino*); magnetic oxydulated iron; blue and green carbonate of copper, and sulphuret of antimony. The most abundant metals of the celebrated vein called the *veta grande*, are prismatic black silver (*sprödglaserz*), sulphuret of silver, or vitreous silver, mixed with native and black silver.

The intendancy of Zacatecas contains the mines of *Fresnillo*, and those of *Sombrerete*. The former are very feebly wrought, and are situated in an insulated group of mountains which rise above the plains of the central table land. These plains are covered with porphyritic formations; but the metalliferous group itself is composed of *grauwacke*. According to the observation of M. Sonneschmidt, the rock is traversed there by an innumerable quantity of veins, rich in grey and green *hornsilver*.

The mines of Sombrerete have become celebrated, from the immense riches of the vein of the *veta negra*, which in the space of a few months left to the family of Fagoaga, (Marques del Apartado) a net profit of more than

20 millions of livres tournois.* The most part of these veins are found in a compact limestone, which contains like that of the Sauceda flint-slate, and lydian stone. The *deep-red silver* particularly abounds in this district of mines; and it has been seen to form the whole mass of the veins which have more than a metre in width † (*puissance*). Near Sombrerete the mountains of secondary calcareous formation, rise much above the porphyritic mountains. The Cerro de Papanton appears to be more than 3400 metres ‡, above the level of the sea.

The mineral repository of Catorce, holds at present the second or third rank among the mines of New Spain, classing them according to the quantity of silver which they produce. It was only discovered in the year 1778. This discovery, and that of the veins of Gualgayoc, in Peru, vulgarly called the veins of Chota, are the most interesting in the history of the mines of Spanish America, for the last two centuries. The small town of Catorce, the true name of which is *la Purissima Concepcion de Alamos de Catorce*, is situated on the calcareous table land, which declines towards the *nuevo reyno de Leon*, and towards the

* 833,400 Sterling. *Trans.*

† More than 3 feet 3 inches. *Trans.*

‡ 11,184 feet. *Trans.*

province of New Santander. From the bosom of these mountains * of secondary compact limestone, masses of basalt, and porous amygdaloid rise up as in the Vicentin, which resemble volcanic productions, and contain olivine, zeolite, and obsidian. A great number of veins of small extent, and very variable in their breadth and direction, traverse the limestone, which itself covers a *transition clay slate*; and the latter perhaps is superimposed on the syenitic rock of the *Buffa del Fraile*. The greatest number of these veins are western (*spathgänge*); and their inclination is from 25° to 30° towards the north-east.† The minerals which form the *gangue* are generally found in a state of decomposition. They are wrought with the *mattock*, the *pickaxe*, and with the *bore*, (*pointrole*). The consumption of powder is much less than at Guanaxuato, and at Zacatecas. These mines possess also the great advantage of being almost entirely dry, so that they have no need of costly machines to draw off the water.

In 1773, Sebastian Caronado, and Antonio Llanas, two very poor individuals, discovered veins in a situation now called *Cerro de Catorce Viejo*, on the western slope of the *Pi-*

* Near the mine del Padre Flores, and on the road from San Ramon to Catorce, (*Sonneschmidt*, p. 279).

† Descripcion del Real de Catorce, *por Don Jose Manuel Gonzales Cueto*, 1800 (Manuscript).

chaco de la Variga de Plata. They began to work these veins, which were poor and inconstant in their produce. In 1778, Don Barnabé Antonio de Zepeda, a miner of the *Ojo del Agua de Matchuala*, investigated during three months this group of arid and calcareous mountains. After attentively examining the ravins, he was fortunate enough to find the *crest* or surface of the *veta grande*, on which he immediately dug the pit of *Guadalupe*. He drew from it an immense quantity of muriate of silver, and *colorados* mixed with native gold; and gained in a short time more thon half a million of piastres. * From that period, the mines of Catorce were wrought with the greatest activity. That of *Padre Flores* alone produced in the first year 1,600,000 piastres †; but the vein only displayed great riches from 50 to 150 metres‡ of perpendicular depth. The famous mine of *Purissima* belonging to Colonel Obregon, has scarcely ever ceased since 1788, to yield annually a net profit of 200,000 piastres§; and its produce in 1796 amounted to 1,200,000 piastres, while the expences of working did not amount to more than 80,000. The vein of *Purissima*, which is not

* £ 109,383 sterling. *Trans.*

† Upwards of £ 350,000 sterling. *Trans.*

‡ From 164 to 328 feet. *Trans.*

§ £ 43,752 sterling. *Trans.*

the same with that of *Padre Flores*, sometimes reaches the extraordinary extent of 40 metres* ; and it was worked in 1802 to the depth of 480 metres.† Since 1798, the value of the minerals of Catorce has singularly diminished ; the native silver is now rarely to be seen ; and the *metales colorados*, which are an intimate mixture of muriate of silver, earthy carbonate of lead, and red ocre, begin to give place to pyritous and coppery minerals. The actual produce of these mines is nearly 400,000 marcs of silver annually. ‡

The mines of *Pachuca*, *Real del Monte*, and *Moran*, are highly celebrated for their antiquity, their wealth, and their proximity to the capital. Since the beginning of the eighteenth century, the vein of *la Biscaina*, or *Real del Monte*, has alone been wrought with activity. The working of the mines of Moran was only resumed within these few years ; and the *mineral depository* of Pachuca, one of the richest of all America, has been wholly abandoned since the terrible fire which took place in the famous mine *del Encino*, which alone furnished more than 30,000 marcs of silver annually.§ The wooden work which supported the *roof*

* 131 feet. *Trans.*

† 1574 feet. *Trans.*

‡ 262,526 lb. Troy. *Trans.*

§ 19,689 lb. Troy. *Trans.*

of the galleries was consumed by fire, and the greatest number of the miners were suffocated before being able to reach the shafts. A similar conflagration in 1787, put a stop to the working of the mines of Bolaños, which were only again begun to be cleared out in 1792.

The valley of Mexico is separated from the basin of *Totonilco el Grande*, by a chain of porphyritic mountains, of which the highest summit* is the peak of the Jacal, elevated according to my measurement with the assistance of the barometer, 3124 metres† above the level of the sea. This porphyry serves for base to the porous amygdaloid, which surrounds the lakes of Tezcuco, Zumpango, and San Christobal. It seems to be of the same formation with that, which in the road from Mexico to Acapulco, immediately covers the *granite* between Sopilote and Chilpansingo, near the village of Acaguisotla, and l'Alto de los Caxones. To the north-east of the district of Real del Monte, the porphyry is at first concealed under the *columnar basalt* of the farm of Regla, and farther on in the valley of Totonilco, under beds of secondary formation. The *Alpine limestone* of a greyish blue, in which is the famous cavern of Danto, called also the *pierced moun-*

* See my *Nivellement Barometrique*, p. 40—42 n. 290—312.

† 10,248 feet. *Trans.*

tain, or *the bridge of the Mother of God* *, seems to repose immediately on the porphyry of Moran. It contains near the Puerto de la Mesa, veins of galena, and we find it covered with three other formations of not so old an origin, which naming them in the order of their superposition, are *Jura limestone*, near the baths of Totonilco, the *slaty limestone* of Amojaque, and a *gypsum* of *secondary formation* mixed with clay. The position of these secondary rocks which I carefully observed, is so much the more remarkable, as it is the same with that which has been discovered on the Old Continent, according to the excellent observations of M. M. de Buch and Freiesleben.

The mountains of the district of mines of Real del Monte, contain beds of porphyry, which, with respect to their *relative antiquity*, differ a good deal from one another. The rock which forms the *roof* and the *wall* of the argentiferous veins, is a decomposed porphyry of which the base sometimes appears clayey, and sometimes analogous to splintery hornstone. The presence of hornblende is frequently announced, merely by greenish stains intermingled with common and vitreous felspar. At very great elevations, for example, in the beautiful forest of oak and pine of Oyamel, we

* *Puente de la Madre de Dios.*

find porphyries with a base of *pearlstone*, containing obsidian in layers and nodules.

What relation exists between these last beds, which several distinguished mineralogists consider as volcanic productions, and the porphyries of Pachuca, Real del Monte, and Moran, in which nature has deposited enormous masses of sulphuret of silver and argentiferous pyrites? This problem, which is one of the most difficult in geology, will only be resolved when a great number of zealous and intelligent travellers, shall have gone over the Mexican Cordilleras, and carefully studied the immense variety of porphyries which are destitute of quartz, and which abound both in hornblende and vitreous felspar.

The district of mines of Real del Monte does not display as at Freiberg in Saxony, Derbyshire in England, or as in the mountains of Zimapan and Tasco in New Spain, a great number of rich veins of small size, on a small tract of ground. It rather resembles the mountains of the Hartz, and Schemnitz, in Europe, or those of Guanaxuato and Potosi, in America, of which the riches are contained in a few mineral depositions of very considerable dimensions. The four veins of Biscaina, Rosario, Cabrera, and Encino, run through the districts of Real del Monte, from Moran

and Pachuca, at extraordinary distances, without changing their direction, and almost without coming in contact with other veins which traverse or *derange* them.

The *veta de la Biscaina* of less considerable dimensions, but perhaps still richer than the vein of Guanaxuato, was succesfully wrought from the sixteenth to the beginning of the eighteenth century. In 1726 and 1727, the two mines of Biscaina and Xacal, still produced together 542,700 marcs of silver.* The great quantity of water which filtrated through the crevices of the porphyritic rock, joined to the imperfection of the means of drawing it off, compelled the miners to abandon the works when they were yet only 120 metres† in depth. A very enterprising individual, Don Joseph Alexandro Bustamente, was courageous enough to undertake a level near Moran; but he died before completing this great work, which is 2352 metres‡ in length from its mouth, to the point where it crosses the vein *de la Biscaina*. The direction of this vein is hor. 6; and its inclination is 85° to the south: its extent is from four to six metres.§ The direction of the porphyry of this district is generally hor. 7-8, with an incli-

* 356,182 lb. Troy. *Trans.*

† 393 feet. *Trans.*

‡ 7715 feet. *Trans.*

§ From 13 to 19 feet. *Trans.*

nation of 60° to the north-east, particularly in the road from Pachuca to Real del Monte. The level is at first cut through the *solid rock*, (*querschlagsweise*) in a direction of hor. 7, towards the west; but farther on it takes its way over three different veins, hor. 11-12, of which one alone the *veta de le Soledad* *, has furnished a sufficiency of silver ores to pay all the expences of the undertaking. The level was only finished in 1762, by Don Pedro Tereros, the partner of Bustamente. The former known by the title of Count de Regla, as one of the richest men of his age, had already drawn, in 1774, a net profit of more than 25 millions of livres tournois†, from the mine of Biscaina. Besides the two ships of war which he presented to King Charles the Third, one of them of 120 guns, he lent five millions of francs‡ to the Court of Madrid, which have never yet been repaid him. He erected the great works of Regla, at an expence of 10 millions§; and he purchased estates of an immense

* It is believed that this vein is the same with that which M. D'Elhuyar, began to work in the pit of Cambrera, at Moran. It appeared to me however that the *veta de Cabrera*, is rather the same with that of *Santa Brigida*, and that its principal wealth is to be found in following it towards the mine of Jesus.

† £ 1,041,750 Sterling. *Trans.*

‡ £ 208,350 Sterling. *Trans.*

§ £ 416,700 Sterling. *Trans.*

extent, and left a fortune to his children, which has only been equalled in Mexico, by that of the Count de la Valenciana.

The level of Moran traverses the vein of *la Biscaina*, in the San Ramon shaft, at a depth of 210 metres*, below the level of the surface, on which the *baritels à chevaux* are placed. The profit of the proprietor has been annually diminishing since 1774. In place of cutting *galleries of investigation*, to discover the vein on a great extent, they continued their *sinking operations* to a depth of 97 metres below the level.† At that depth, the vein preserved its great wealth in sulphuret of silver, mixed with native silver, but the abundance of water increased to such a degree, that 28 *baritels*, each of which required more than 40 horses, were not sufficient to draw it off. In 1783, the weekly expence amounted to 45,000 francs.‡ After the death of the old Count de Regla, the works were suspended till 1791, when they ventured to re-establish all the *baritels*. The expence of these machines which drew up the water, not by means of *pumps*, but by bags suspended by ropes, then amounted to more than 750,000 francs per annum.§ At length they reached

* 688 feet. *Trans.*

† 317 feet. *Trans.*

‡ £1875 Sterling. *Trans.*

§ £31,252 Sterling. *Trans.*

the deepest point of the mine, which according to my measurements* is only 324 metres† above the level of the lake of Zumpango; but the ores which they extracted did not compensate the expence of the process, and the mine was again abandoned in 1801.

It is surprising that they never thought of substituting to this wretched plan of drawing off the water by bags, proper pump apparatus, put in motion by horse *baritels*, by hydraulical wheels, or by machines moved by a column of water (*colonne d'eau*). A level begun at Pachuca, or lower down towards Gazave in the valley of Mexico, would have exhausted the mine of Biscaina at the pit of San Ramon, for a depth of 370 metres.‡ The same object could be attained at less expence, by following the project of M. D'Elhuyar, in placing the mouth of a new level near Omitlan, in the road which leads from Moran, to the place of amalgamation at Regla. This

* I found the absolute height of the lake of Zumpango, 2284 metres (7492 feet. *Trans.*); the pit of San Ramon 2815 metres (9233 feet. *Trans.*); now the deepest point of the mine of Biscaina is 307 metres (1006 feet. *Trans.*) below the upper mouth of the pit. I insert these results here, because in the country it is generally believed, that the works of the Real del Monte have already reached the level of the salt lake of Tezeuco.

† 1062 feet. *Trans.*

‡ 1213 feet. *Trans.*

last level before reaching 3800 metres* in length, would cut the vein of Biscaina.

The very wise plan which the Count de Regla at present follows is, to leave off the clearing of the old works, and to investigate the *mineral repository*, in points where it has never yet been worked (*in unverfahrenem felde*). In studying at Real del Monte, the surface and undulations of the ground, we observe that the vein of Biscaina has furnished for three centuries its greatest riches on a single point, that is to say, in a natural deepening (*enfoncement*) contained between the shafts of Dolores, Joya, San Cayetano, Santa Teresa, and Gaudalupe. The shaft from which the greatest quantity of silver ores has been extracted, is that of Santa Teresa. To the east and west of this central point, the vein is contracted for a distance of more than 400 metres.† It preserves its primitive direction, but becomes destitute of metals, and reduced to an almost imperceptible vein. For a long time it was believed that the vein of Biscaina was insensibly lost in the rock; but they discovered in 1798 very rich metals, at a distance of more than 500 metres‡, to the east and west of the centre of the old works. They then

* 12,466 feet. *Trans.*
† 1312 feet. *Trans.*
‡ 1640 feet. *Trans.*

sunk the shafts San Ramon and San Pedro; and they discovered that the vein resumed its old power, and that an immense field was opened to new undertakings. When I visited the mines in the month of May 1803, the San Ramon shaft was only then 30 metres in depth*; and it will be nearly 240 metres† to the bottom of the level of Moran, which is itself still distant 45 metres‡ from the point which corresponds to the intersection of the new shaft, and the roof of the level. In its present state, the mine of the Count de Regla, annually yields more than from 50 to 60,000 marcs of silver.§

The vein of Biscaina contains in the points of the principal mines, milk-quartz, which frequently passes into splintery hornstone, amethyst, carbonate of lime, a little sulphate of barytes, sulphuret of silver mixed with native silver, and sometimes prismatic black silver (*sprödglaserz*), deep-red silver, galena and iron and copper pyrites. The same silver ores are found near the surface of the ground in a state of decomposition, and mixed with oxide of iron, like the *pacos* of Peru. Near the San Pedro shaft, the pyrites are some-

* 98 feet. *Trans.*
† 787 feet. *Trans.*
‡ 147 feet. *Trans.*
§ From 32,815 to 39,378 lb. Troy. *Trans.*

times richer in silver than the sulphuret of silver.

The mines of Moran, formerly of great celebrity, have been abandoned for 40 years, on account of the abundance of water which they could not draw off. In this district of mines, which is in the vicinity of that of Real del Monte, near the mouth of the great level of Biscaina, there was placed in 1801 a machine *à colonne d'eau*, of which the cylinder is 26 centimetres in height, and 16 in diameter.* This machine the first of the kind ever constructed in America, is much superior to those of the mines of Hungary. It was executed agreeably to the calculations and plans of M. del Rio, professor of mineralogy in Mexico, who has visited the most celebrated mines of Europe, and who possesses at once the most solid and various acquisitions. The merit of the execution is due to M. Lachausée, a Brabant artist of great talents, who has also fitted up for the school of mines of Mexico, a very remarkable collection of models, for the use of students of mechanics and hydrodynamics.† It is to be regretted that this fine machine, in which the regulator of the suckers‡ is put in

* 10.23 by 6.29 inches. *Trans.*

† See Vol. i. p. 216.

‡ *Delius, des mines de Schemnitz*, edition of M. Schreiber, § 591.

motion by a particular mechanism, was placed in a situation where there is great difficulty in procuring a sufficiency of water to keep it going. When I was at Moran, the pumps could only work three hours a day. The construction of the machine and the aqueducts cost 80,000 piastres*; they did not at first calculate on more than half of the expence, and they imagined the mass of water to be very considerable; but the year in which the water was measured being exceedingly rainy, it was believed to be much more abundant than it actually was. It is to be hoped that the new canal which was going on in 1803, and which will be 5000 metres† in length, will remedy this want of water, and that the vein of Moran (hor. $9\frac{1}{3}$ inclined 84° to the north-east), will be found as rich at great depths, as the shareholders of the mine suppose. M. del Rio, on my arrival in New Spain, had no other view but that of proving to the Mexican miners the effect of machines of this nature, and the possibility of constructing them in the country. This object has been in part attained; and it will be much more evidently attained when such a machine shall be placed in the mine of Rayas, at Guanaxuato, in that of the

* £10,937 Sterling. *Trans.*

† 16,404 feet. *Trans.*

Count de Regla, at Real del Monte, or in those of Bolaños, where M. Sonneschmidt*, counted nearly 4000 horses and mules employed in moving the baritels.

The mines of the *district of Tasco*, situated on the western slope of the Cordillera, have lost their antient splendour, since the end of the last century; for in their present state, the veins of Tehuilotepec, Sochipala, Cerro del Limon, San Estevan, and Gautla, do not altogether yield more than 60,000 marcs of silver annually.† During the year 1752 and the ten following years, the mines of Tasco were wrought with the greatest activity and success. This activity was owing to the enterprising mind of Joseph Laborde, a Frenchman, who came into Mexico very poor, and who in 1743, acquired immense wealth in the mine of la Cañada of the *Real de Tlapujahua*. We have already spoken‡ in another place of the reverses of fortune several times experienced by this extraordinary man. After building a church at Tasco, which cost him 400,000 piastres §, he was reduced to the lowest poverty, by the rapid decline of those very mines, from which

* Sonneschmidt, p. 241.

† 39,378 lb. Troy. *Trans.*

‡ Vol. ii. p.186.

§ £87,507 Sterling. *Trans.*

he had annually drawn from 2 to 300,000* marcs of silver. The archbishop having given him permission to sell a golden sun enriched with diamonds, with which he had adorned the tabernacle of the church of Tasco, he withdrew to Zacatecas with the produce of this sale which amounted to 100,000 piastres.† The district of mines of Zacatecas was then in such a state of abandonment, that it scarcely furnished fifty thousand marcs‡ of silver annually to the mint at Mexico. Laborde undertook to clear out the famous mine of Quebradilla, in which undertaking he lost all his property, without attaining his object. With the small capital which remained to him, he began to work on the *veta grande*, and sunk the pit of *La Esperanza*, when a second time he acquired immense wealth. The silver produce of the mine of Zacatecas rose then to 500,000 marcs § per annum; and though the abundance of metals did not long continue the same, he left at his death a fortune of nearly three millions of livres Tournois.‖ He compelled his daughter to enter into a convent, that he might leave his whole fortune to an only son, who afterwards voluntarily embraced the

* From 131,263 to 196,894 lb. troy. *Trans.*

† 21,876*l.* sterling. *Trans.*

‡ 32,815 lb. troy. *Trans.*

§ 328,153 lb. troy.

‖ 125,010*l.* sterling. *Trans.*

ecclesiastical office. In Mexico, and every where else in the Spanish provinces, it is extremely rare to see children following the profession of their fathers; and we do not find there, as in Sweden, Germany, and Scotland, families, in which the business of miner is hereditary.

The veins of Tasco, and the Real de Tehuilotepec, traverse barren mountains, furrowed by very deep ravins. The oldest rock which appears at the surface in this district of mines, is primitive clay-slate (*thonschiefer*), which passes into micaceous slate. Its direction is hor. 3—4; and its inclination 40° to the north-west, as I observed in the Cerro de San Ignacio, and to the west of Tehuilotepec, in the Cerro de la Compaña, where Cortez began his gallery of investigation. The micaceous slate probably rests on the granite of Zumpango, and on that of the valley of Papagallo; and it appears covered near Achichintla, and Acamiscla, with a porphyritic formation, which contains both common and vitreous felspar, and beds of blackish brown *pitch-stone* (*pechstein*). In the environs of Tasco, Tehuilotepec, and Limon, primitive slate serves for base to the bluish-grey, and frequently porous compact limestone belonging to the *alpine formation*. This limestone contains many *subordinate beds*, some of lamellar gypsum, and others of slate-clay,

(*schieferthon*) charged with carbon. In ascending from the banks of the lake of Tuspa to the *Subida de Tasco el Viejo*, we found petrifactions of trochites, and other univalve shells, contained in this limestone. The stratification was very marked, but its banks follow by groups different directions and inclinations. A grey stone with a calcareous cement reposes on this limestone of Tasco, the same with that which covers the plains of Sopilote, and the fertile table land of Chilpansingo.

The mining districts of Tasco, and of the Real de Tehuilotepec contains a great number of veins, which, with the exception of the Cerro de la Compañia, are all directed from the north-west to the south-east, hor. 7—9. These veins, like those of Catorce, traverse both the limestone and the micaceous slate which serves for its base; and they exhibit the same metals in both rocks. These metals have been much more abundant in the limestone. The mines have become extremely poor since they were compelled to work the veins in the micaceous slate. A very intelligent and a very active miner, Don Vicente de Anza, wrought the mines of Tehuilotepec to the depth of 224 metres *; and he cut two excellent levels for a length of 1200

* 734 feet. *Trans.*

metres*; but unfortunately he found that the same veins which had furnished considerable riches at the surface of the earth, were at great depths as poor in red silver ores, as abundant in galena, pyrites, and yellow blende.

An extraordinary event which happened on the 16th February 1802, completed the ruin of the miners of this district. The mines of Tehuilotepec, like those of Guautla, have at all times wanted the necessary water to put in motion the *bocards* and other machines, which prepare the minerals for the process of amalgamation. The most abundant stream used in the works, issued from a cavern in the limestone rock, called the *Cueva de San Felipe*. This rivulet was lost in the night between the 16th and 17th of February, and five days afterwards, a new spring was found at five leagues distance from the cavern, near the village of Platanillo. It has been proved by researches of the greatest interest for geology, of which I shall speak in another place, that there exists in this country, between the villages of Chamacasapa, Platanillo, and Tehuilotepec, in the bosom of calcareous mountains, a series of caverns and natural galleries, and that subterraneous rivers, like those of the

* 3936 feet. *Trans.*

county of Derby in England, traverse those galleries, which communicate with one another.

The veins of Tehuilotepec are in general *western* (*spatgänge*); they are from two to three metres in extent *, and being separated from the rock by a list of clayey loam, they form several *lateral branches*, which enrich the principal vein where they *accompany* it (*se trainent*). Their structure has this particularity, that the metallic mineral is rarely disseminated throughout all the *gangue*, but collected in a single band, which is sometimes near the roof, and sometimes near the wall of the vein. In general, the mineral depositories of Tasco and Tehuilotepec are extremely *inconstant* in their produce. As to the nature of the mass of which they are constituted, I perceived four very different *formations of veins*, viz.

1. Brown, red, and yellow oxides of iron, in which native and sulphuretted silver are disseminated in impalpable particles; cellular brown ironstone, specular iron, a little galena, and magnetic iron, and blue carbonate of copper. This formation, analogous to that of the *pacos* of Fuentestiana, and Pasco in Peru, is designated at Tehuilotepec, by the name of *tepostel*. It is found at small depths *from the*

* From 6 to 9 feet. *Trans.*

surface (*in ausgehenden*) in the mines of San Miguel, San Estevan, and La Compaña, near Tasco, as well as at the Cerro de Garganta, near Mescala. The *tepostel*, is generally not so rich as the Pasco of Peru; but is so much the richer at Tasco, as the oxide of iron is more mixed with azure of copper; but it generally, however, does not contain more than four ounces of silver per quintal.

2. Calcareous spar, a little galena, and transparent lamellar gypsum, containing drops of water with air, and filiform native silver. This small and very remarkable formation, which has been also observed in the mountains of Saltzbourg, is found at the depth of more than 100 metres* on the vein of Trinidad, which is the continuation of the vein of San Miguel, in a point where the *wall* is not gypsum, but compact limestone.

3. Light-red silver, brittle vitreous silver (*sprödglaserz*), much yellow blende, galena, very little of iron pyrites, calcareous spar, and milk quartz. This formation, which is the richest of all, displays the remarkable phenomenon, that the minerals the most abundant in silver, form spheroidal balls, from ten to twelve centimetres in diameter†, in which red silver, mixed with brittle vitreous silver, and

* 328 feet. *Trans.*

† From 3.93 to 4.71 inches. *Trans.*

native silver, alternate with bands of quartz. These balls, which have been seldom seen but between 15 and 60 metres* of depth, are nidulating in a gangue of calcareous and brown-spar. They have been observed in the three veins of San Ignacio, Dolores, and Perdon, of which the masses are filled with *druses*, lined with beautiful crystals of carbonate of lime.

4. Much argentiferous galena, which is richer in silver in proportion as the *separated pieces* are of smaller grain; much yellow blende; little pyrites; quartz, and calcareous spar, in the mines of Socabon del Re, and de la Marquesa.

All these veins run through a table land of from 17 to 1800 metres in elevation † above the surface of the sea, which enjoys a temperate climate, very favourable to the cultivation of the cerealia of the Old Continent.

When we take a general view of the mining operations of New Spain, and compare them with those of the mines of Freiberg, the Hartz, and Schemnitz, we are surprised at still finding in its infancy, an art which has been practised in America for these three centuries, and on which, according to the vulgar prejudice, the

* Between 48 and 196 feet. *Trans.*

† From 5556 to 5910 feet. *Trans.*

prosperity of these ultramarine establishments depends. The causes of this phenomenon cannot escape those who, after visiting Spain, France, and the western parts of Germany, have seen that mountainous countries still exist in the centre of civilized Europe, in which the mining operations partake of all the barbarity of the middle ages. The art of mining cannot make great progress, where the mines are dispersed over a great extent of ground, where the government allows to the proprietors the full liberty of directing the operations without controul, and of tearing the minerals from the bowels of the earth, without any consideration of the future. Since the brilliant period of the reign of Charles the 5th, Spanish America has been separated from Europe, with respect to the communication of discoveries useful to society. The imperfect knowledge which was possessed in the 16th century relative to mining and smelting, in Germany, Biscay, and the Belgic provinces, rapidly passed into Mexico and Peru, on the first *colonization* of these countries; but since that period, to the reign of Charles the third, the American miners have learned hardly any thing from the Europeans, but the blowing up with powder* those rocks which resist the

* This art was only introduced into the mines of Europe towards the year 1613. (*Daubuisson*, t. i. p. 95.)

pointrole. This King and his successor have shewn a praiseworthy desire of imparting to the colonies all the advantages derived by Europe from the improvement in machinery, the progress of chemical science, and their application to metallurgy. German miners have been sent at the expence of the court to Mexico, Peru, and the kingdom of new Grenada; but their knowledge has been of no utility, because the mines of Mexico are considered as the property of the individuals, who direct the operations, without the government being allowed to exercise the smallest influence.

We shall not here undertake to detail the defects which we believe we have observed in the administration of the mines of New Spain, but shall confine ourselves to general considerations, remarking whatever appears to us worthy of fixing the attention of the European traveller. In the greatest number of the Mexican mines the operations with the *pointrole*, which requires the greatest address on the part of the workman, are very well executed. The *mallet* might indeed be somewhat less heavy; it is the same tool which the German miners used in the time of Charles the 5th. Small moveable forges are placed in the interior of the mines, to re-forge the point of the pointroles, when they are unfit for working. I

reckoned 16 of these forges in the mine of Valenciana; and in the district of Guanaxuato, the smallest mines have at least one or two. This arrangement is very useful, particularly in mines which employ even 1500 workmen, and in which there is consequently an immense consumption of steel. I cannot say much in praise of the method of blasting with powder. The holes for the reception of the cartridges are generally too deep, and the miners are not sufficiently careful in diminishing the mass of the rock intended to yield to the explosion. A great waste of powder is consequently occasioned by these defects. The mine of Valenciana consumed *, from 1794 to 1802, powder to the amount of 673,676 piastres †, and the mines of New Spain annually require from 12 to 14,000 quintals. It is probable that two thirds of this quantity is uselessly employed. At Chapoltepec, near Mexico, and in the mine of Ray as near Guanaxua to, some

* In 1799, 63,375 piastres; in 1800, 68,493 piastres, in 1801, 78,243 piastres; in 1802, 79,903 piastres. The miner is paid at Guanaxuato, for a hole of 1 m. 5 in depth (4 feet 11 inches. *Trans.*) 12 francs (ten shillings); for a hole of 1m. 9 (75.8 inches) in depth, 9 francs (7s. 6d.) without including powder and tools, which are furnished to him. In the mine of Valenciana, nearly 600 holes *by two men each* are made every 24 hours.

† £147,377 Sterling.

experiments have been made of the method of blasting, proposed by M. Bader; a method by which a certain volume of air must be left between the powder and the wad. Although these experiments have proved the great advantage of the new method, the old has still continued to prevail, on account of the small degree of interest taken by the *master miners* in reforming the abuses, and perfecting the art of mining.

The lining with wood is very carelessly performed, though it ought the more to engage the consideration of the proprietors, as wood is becoming year after year more scarce on the table land of Mexico. The *mason work* employed in the shafts and galleries *, and especially the *walling* with lime, deserves a great deal of praise. The *arches* are formed with great care, and in this respect the mines of Guanaxuato may stand a comparison with whatever is most perfect at Freiberg and Schemnitz. The shafts, and still more the galleries of New Spain, have generally the defect of being dug in too great dimensions, (*ortstosshöhe*) and of occasioning, by that means, very exorbitant expences. We find galleries at Valenciana †,

* Especially in the mines of Valenciana, Guanaxuato, and the Real del Monte.

† Canon de la Soledad.

executed with the view of investigating a *sterile* vein, of a height of eight or nine metres.* It is an erroneous opinion, that this great height facilitates the renovation of the air; but the *ventilation* solely depends on the equilibrium and difference of temperature between two neighbouring columns of air. They believe also, equally without any foundation, that, in order to discover the nature of a very powerful vein, very large *galleries of investigation* are requisite, as if in mineral depositories of from twelve to fifteen metres † in extent, it were not better to cut from time to time small *cross galleries* towards the *wall* and the *roof*, for the purpose of discovering whether the mass of the vein begins to grow richer. The absurd custom of cutting every gallery in such enormous dimensions, prevents the proprietors from multiplying the *labours of investigation*, so indispensable for the preservation of a mine, and the length of duration of the works. At Guanaxuato, the breadth of the oblique pits dug stairwise, is from ten to 12 metres ‡; and the perpendicular pits are generally six, eight, or ten metres || broad. The enormous quantity of ores extracted from

* 26 or 29 feet. *Trans.*

† From 38 to 48 feet. *Trans.*

‡ From 32 to 36 feet. *Trans.*

|| 19, 26, or 32 feet. *Trans.*

the mines, and the necessity of introducing into them cables attached to six or eight *horse baritels*, necessarily occasion the shafts of Mexico to be made of greater dimensions than those in Germany; but the attempt which has been made at Bolaños to separate by beams the cables of the baritels, has sufficiently proved that the breadth of the shafts may be diminished without any danger of the ropes entangling in their oscillatory motion. It would in general be very useful to make use of *casks*, or rectangular parallelopipeds, instead of leathern bags suspended by cables, for the extraction of the ores. Several pairs of these casks running by means of wheels on *conducting beams*, might ascend and descend in the same shaft.

The greatest fault observable in the mines of New Spain, and which renders the working of them extremely expensive, is the want of communication between the different *works*. They resemble ill-constructed buildings, where, to pass from one adjoining room to another, we must go round the whole house. This mine of Valenciana is very justly admired on account of its wealth, the magnificence of its walling, and the facility with which it is entered by spacious and commodious stairs; but yet it exhibits only a union of small works, too irregular to merit the appellation of gradual works (*ouvrages à gradins*); they are, as

it were, sacks, with only one opening at the top, and without any lateral communication. I mention this mine, not because it is more faulty than the others in the distribution of its labours, but because it ought, naturally, to be believed better organized. As subterraneous geometry had been entirely neglected in Mexico, till the establishment of the school of mines, there is no plan in existence of the *works* already executed. Two works in that labyrinth of *cross galleries*, and interior shafts, may happen to be very near one another, without its being possible to perceive it. Hence the impossibility of introducing, in the actual state of the most part of the mines of Mexico, the wheeling by means of *barrows* or *dogs*, and an economical disposition of the *places of assemblage*. A miner brought up in the mines of Freiberg, and accustomed to see so many ingenious means of conveyance practised, can hardly conceive that, in the Spanish colonies, where the poverty of the ores is united to a great abundance of them, all the metal which is taken from the vein, should be carried on the backs of men. The Indian *tenateros*, who may be considered as the beasts of burden of the mines of Mexico, remain loaded with a weight of from 225 to 350 pounds* for a space of six hours. In the galleries of Valen-

* From 242 to 377 lb. avoird. *Trans.*

ciana and Rayas, they are exposed, as we have already observed in speaking of the health of the miners*, to a temperature of from 22° to 25°†; and during this time they ascend and descend several thousands of steps in pits of an inclination of 45°. These *tenateros* carry the minerals in bags (*costales*) made of the thread of the pité. To prevent their shoulders from being hurt, (for the miners are generally naked to the middle) they place a woollen covering (*frisada*) under this bag. We meet in the mines with files of fifty or sixty of these porters, among whom there are men above sixty, and boys of ten or twelve years of age. In ascending the stairs they throw the body forwards, and rest on a staff, which is generally not more than three decimetres in length.‡ They walk in a zigzag direction, because they have found from long experience (as they affirm) that their respiration is less impeded when they traverse obliquely the current of air which enters the pits from without.

We cannot sufficiently admire the muscular strength of the Indian and Mestizoe *tenateros*

* Vol. i. p. 125. At Paris the porters called *Forts de la Halle*, are generally loaded with bags of flour, which weigh 325 pounds. (350 lb. avoird. *Trans.*) To be received in their corporation, a man must carry for 25 minutes, a weight of 850 pounds, (916lb. avoird. *Trans.*)

† From 71° to 77° Fahren. *Trans.*

‡ About a foot. *Trans.*

of Guanaxuato, especially when we feel ourselves oppressed with fatigue in ascending from the bottom of the mine of Valenciana without carrying the smallest weight. The *tenateros* cost the proprietors of Valenciana more than 15,000 livres Tournois weekly*; and they reckon that three men destined to carry the ores to the places of assemblage are for one employed workman (*barenador*) who blows up the gangue by means of powder. These enormous expences of transportation would be perhaps diminished more than two thirds, if the works communicated with one another by interior shafts (*rollschächte*), or by galleries adapted for *conveyance by wheel-barrows and dogs*. Well contrived operations would facilitate the extraction of minerals and the circulation of air, and would render this great number of *tenateros* unnecessary, whose strength might be employed in a manner more advantageous to society, and less hurtful to the health of the individual. Interior pits communicating from one gallery to another, and serving for the extraction of ores, might be provided with *cranes* (*haspel*) to be wrought by men, or *baritels*, to be moved by cattle. For a long time (and this arrangement undoubtedly deserves the attention of the European miner) mules have been employed in

* £624 Sterling. *Trans.*

the interior of the mines of Mexico. At Rayas these animals descend every morning without guides and in the dark, the steps of a pit of an inclination from 42° to 46°. The mules distribute themselves of their own accord in the different places where the machines for drawing up the water are placed, and their step is so sure, that a lame miner was accustomed several years ago, to enter and leave the mine on one of their backs. In the district of the mines of Peregrino, at the *Rosa de Castilla*, the mules sleep in subterraneous stables, like the horses which I saw in the famous rock salt mines of Wieliczka in Gallicia.

The smelting and amalgamation works of Guanaxuato and Real del Monte, are so placed that two *navigable galleries* with their openings near Marfil and Omitlan might serve for the carriage of ores, and render every sort of draught above the level of the galleries superfluous. Besides the descents from Valenciana to Guanaxuato, and from Real del Monte to Regla are so rapid, that they would admit of the making of railways, on which waggons loaded with the ores destined for amalgamation might be easily rolled along.

We have already spoken of the truly barbarous custom of *drawing off* the water from the deepest mines, not by means of *pump apparatus*, but by means of bags attached to ropes which

roll on the *drum* of a *horse baritel.* The same bags are used in drawing up the water, and the ores: they rub against the walls of the shafts, and it is very expensive to keep them in repair. At the Real del Monte, for example, these bags only last seven or eight days; and they commonly cost six and sometimes eight or ten francs a piece. A bag full of water, suspended to the *drum* of a *baritel* with eight horses (malacate doble) weighs 1250 pounds: it is made of two hides sowed together. The bags used for the *baritels* called *simple*, those with four horses (*malacates sencillos*) are only the half of the size, and are made of one hide. In general the construction of the *baritels* is extremely imperfect, and they have besides, the bad custom of forcing the horses, by which they are moved to run with by far too great a speed. I found this speed at the shafts of San Ramon, at Real del Monte, no less than ten feet and a half per second *; at Guanaxuato in the mine of Valenciana from thirteen to fourteen feet; and every where else I found it more than eight feet. Don Salvador Sein, professor of Natural Philo-

* The water being drawn from a depth of eighty metres, (262 feet. *Trans.*) The *malacate doble* had four *arms*, the extremity of each *arm*, has a kind of axle-tree, to which two horses are yoked. The diameter of the circle described by the horses was seventeen *varas* and a half (about 47½ feet. *Trans*). The diameter of the drum was twelve (32 feet. *Trans.*) The horses are changed every four hours.

sophy at Mexico, has proved, in a very excellent paper on the rotatory motion of machines, that notwithstanding the extreme lightness of the Mexican horses, they produce only the *maximum* of effect on the *baritels* when, exerting a force of 175 pounds, they walk at a pace of from five to six feet in the second.

It is to be hoped that they will introduce at last in the mines of New Spain, pump apparatus, moved either by *horse baritels* of a better construction, or by hydraulic wheels, or by machines a *colonne d'eau.* As wood is very scarce on the ridge of the Cordilleras, and coal has only yet been discovered in New Mexico, they are unfortunately precluded from employing the *steam engine*, the use of which would be of such service in the *inundated* mines of Bolaños as well as in those of Rayas and Mellado.

It is in the draining the mines of the water that we particularly feel the indispensable necessity of having plans drawn up by *subterraneous surveyors* (*geometres*). Instead of stopping the course of the water, and bringing it by the shortest road to the pit where the machines are placed, they frequently direct it to the bottom of the mine *, to be afterwards drawn off at a

* At Rayas, for example, where they draw off from a depth of 338 *varas*, water, which might be collected towards the south-east, in a *drain* at the depth of 780 varas.

great expense. Moreover, in the district of mines of Guanaxuato nearly two hundred and fifty workmen perished in the space of a few minutes on the 14th June, 1780, because, not having measured the distance between the works of San Ramon and the *old works of Santo Christo de Burgos*, they had imprudently approached this last mine while carrying on a gallery of investigation in that direction. The water with which the works of Santo Christo were full, flowed with impetuosity through this new gallery of San Ramon into the mine of Valenciana. Many of the workmen perished by the effect of the sudden compression of the air, which, in taking a vent, threw to great distances pieces of timber, and large masses of rock. This accident would not have happened, if in regulating the operations they could have consulted a plan of the mines.

After the picture which we have just drawn of the actual state of the mining operations, and of the bad economy which prevails in the administration of the mines of New Spain, we ought not to be astonished at seeing works, which for a long time have been most productive, abandoned whenever they have reached a considerable depth, or whenever the veins have appeared less abundant in metals. We have already observed, that in the famous mine of Valenciana,

the annual expenses rose in the space of fifteen years from two millions of francs to four millions and a half.* Indeed, if there be much water in this mine, and if it require a number of *horse baritels* to draw it off, the profit must, to the proprietors, be little or nothing. The greatest part of the defects in the management which I have been pointing out, have been long known to a respectable and enlightened body, the *Tribunal de Mineria* of Mexico, to the professors of the school of mines, and even to several of the native miners, who without having ever quitted their country, know the imperfection of the old methods; but we must repeat here, that changes can only take place very slowly among a people who are not fond of innovations, and in a country where the government possesses so little influence on the works which are generally the property of individuals, and not of shareholders. It is a prejudice to imagine, that the mines of New Spain on account of their wealth, do not require in their management the same intelligence and the same economy which are necessary to the preservation of the mines of Saxony and the Harz. We must not confound the abundance of ores with their intrinsic value. The most

* From 90,000*l.* to 180,000*l.* Sterling. *Trans.*

part of the minerals of Mexico being very poor, as we have already proved, and as all those who do not allow themselves to be dazzled by false calculations very well know, an enormous quantity of gangue impregnated with metals must be extracted, in order to produce two millions and a half of marcs of silver. Now it is easy to conceive that in mines of which the different *works* are badly disposed, and without any communication with one another, the expense of extraction must be increased in an alarming manner, in proportion as the shafts (*pozos*) increase in depth, and the galleries *cañones*) become more extended.

The labour of a miner is entirely free throughout the whole kingdom of New Spain; and no Indian or Mestizoe can be forced to dedicate themselves to the working of mines. It is absolutely false, though the assertion has been repeated in works of the greatest estimation, that the court of Madrid sends out galley slaves to America, to work in the gold and silver mines. The mines of Siberia have been peopled by Russian malefactors; but in the Spanish colonies this species of punishment has been fortunately unknown for centuries. The Mexican miner is the best paid of all miners; he gains at the least from 25 to 30 francs* per

* From 1*l.* to 1*l.* 4*s.* sterling. *Trans.*

week of six days, while the wages of labourers who work in the open air, husbandmen for example, are seven livres sixteen sous, on the central table land, and nine livres twelve sous* near the coast. The miners, *tenateros* and *faeneros* occupied in *transporting* the minerals to the *place of assemblage* (*despachos*) frequently gain more than six francs† per day, of six hours.‡ Honesty is by no means so common among the Mexican as among the German or Swedish miners; and they make use of a thousand tricks to steal very rich specimens of ores. As they are almost naked, and are searched on leaving the mine in the most indecent manner, they conceal small morsels of native silver, or red sulphuret and muriate of silver in their hair, under their arm-pits, and in their mouths; and they even lodge in their anus, cylinders of clay which contain the metal. These cylinders are called *longanas*, and they are sometimes found of the length of thirteeen centimetres, (five inches). It is a most shocking spectacle to see in the large mines of Mexico, hundreds of workmen, among whom there are a great number of very respectable men, all compelled to allow

* 6s. 3d. and 7s. 6d. *Trans.*

† 4s. 10d. *Trans.*

‡ At Freiberg in Saxony the miner gains per week of five days, from four livres, to four livres ten sous, (from 3s. 3d. to 3s. 8d. *Trans.*)

themselves to be searched on leaving the pit or the gallery. A register is kept of the minerals found in the hair, in the mouth, or other parts of the miners' bodies. In the mine of Valenciana at Guanaxuato, the value of these stolen minerals, of which a great part was composed of the *longanas*, amounted between 1774 and 1787, to the sum of 900,000 francs. *

In the interior of the mines much care is employed in controuling the *tenateros*, by whom the ores are carried towards the pit from the place of *operation*. At Valenciana, for example, they know to within a few pounds the quantity of metalliferous *gangue* which daily goes out of the mine. I say, the *gangue*, for the rock is never there an object of extraction, and is employed to fill up the vacancies formed by the extraction of the minerals. At the *place of assemblage* of the great shafts, two chambers are dug in the *wall*, in each of which two persons (*despachadores*) are seated at a table, with a book before them containing the names of all the miners employed in the carriage. Two balances are suspended before them, near the counter. Each *tenatero* loaded with minerals presents himself at the counter; and two persons stationed near the balances, judge of the weight of this load by raising it lightly up. If

* 63,000 sterling. *Trans.*

the *tenatero*, who, during the road has had time to estimate his load, believes it lighter than the *despachador*, he says nothing, because the error is advantageous to him; but on the other hand, if he believes the weight of the ore he carries in his bag to be greater than it is estimated, he then demands that it should be weighed in the balance; and the weight which is thus determined is entered in the book of the *despachador*. From whatever part of the mine the *tenatero* comes, he is paid at the rate of one *real de plata* for a load of nine arrobas, and one and a half *real* for a load of thirteen arrobas and a half per *journey*. There are some *tenateros* who perform in one day, from eight to ten *journies*, and their pay is regulated from the book of the *despachador*. This mode of reckoning is no doubt highly deserving of praise, and we cannot sufficiently admire the celerity, the order, and the silence with which they thus determine the weight of so many thousand quintals of ores, which are furnished by veins of twelve or fifteen metres * in breadth in a single day.

These ores, which are separated from the sterile rocks in the mine itself, by the master miners (*quebradores*) undergo three sorts of preparation, viz. at the place of banes de triage,

* 38 or 48 feet. *Trans.*

where women work, under the *bocards*, and under the *tahonas* or *arastras*. These tahonas are machines in which the metalliferous gangue is triturated under very hard stones, which have a rotatory motion, and weigh upwards of seven or eight quintals. They are not yet acquainted with washing *with the tub* (setz wäsche) nor washing on sleeping tables (*tables dormantes*) (*liegende heerde*) or percussion (*stossheerde*). The preparation under the bocards (*mazos*) or in the *tahonas*, to which I shall give the name of *mills*, on account of their resemblance to some oil and snuff mills, differs according as the ore is destined to be smelted or amalgamated. The *mills* properly belong only to this last process; however, very rich metallic grains called *polvillos*, which have passed through the trituration of the tahona are also smelted.

The quantity of silver extracted from the ores by means of mercury, is in the proportion of 3½ to 1 of that produced by smelting. This proportion is taken from the general table formed by the provincial treasuries, from the different districts of mines of New Spain. There are, however, some of those districts, for example, those of Sombrerete and Zimapan, in which the produce from smelting exceeds that of amalgamation.

Silver (*plata quintada*) extracted from the mines of New Spain, from the 1st January, 1785, to the 31st December, 1789.

Provincial treasuries receiving the fifth.	Silver extracted by amalgamation (*marcos de azogue*).	Silver extracted by smelting (*marcos de fuego*).
Mexico	950,185	104,835
Zacatecas	1,031,360	173,631
Guanaxuato . . .	1,937,895	531,138
San Luis Potosi . .	1,491,058	24,465
Durango	536,272	386,081
Guadalaxara . . .	405,357	103,615
Bolaños	336,355	27,614
Sombrerete	136,395	184,205
Zimapan	1,215	247,002
Pachuca	269,536	185,500
Rosario	477,134	191,368
Total in marcs	7,572,762	2,159,454

I believe we ought to augment the quantities stated in the preceding table one fifth to come at the real state of the mines. In times of peace, amalgamation gains a gradual ascendancy over smelting, which is generally badly managed. As wood is becoming yearly more scarce on the ridge of the Cordilleras, which is

the most populous part, the diminution of the produce of smelting is very advantageous to the manufactories which require a great consumption of combustibles. In times of war the want of mercury arrests the progress of amalgamation and compels the miner to endeavour to improve the process of *smelting*. M. Velasquez, the director general of the mines, supposed even in 1797, before the discovery of the rich mines of Catorce, where there is scarcely any smelting, that of all the ores of New Spain $\frac{2}{5}$ were smelted, and the other $\frac{3}{5}$ amalgamated.

The limits prescribed by us in the execution of this work, do not permit us to enter into any detail of the processes of amalgamation used in Mexico. It may be sufficient to give a general idea of them, to examine the chemical phenomena which are exhibited in the greatest part of these processes, and to show the difficulties which in the New Continent oppose the introduction of the method invented in Germany in 1786, by Born, Ruprecht, and Gellert. Those who may desire to know thoroughly the practice of American amalgamation, will find the most satisfactory information in a work which Mr. Sonneschmidt proposes to publish. This worthy mineralogist resided in New Spain for the space of twelve years; he had occasion to submit a great number of ores to amalgamation; and

he had it in his power to discover by his own experience, the advantages and disadvantages of the different methods which have been followed since the sixteenth century in the mines of America.

The ancients knew the property which mercury possessed of combining with gold; and they made use of amalgamation in gilding copper, and collecting the gold contained in their worn out dresses, by reducing them to ashes in clay vessels. * It appears even certain that before the discovery of America, the German miners used mercury not only in washing auriferous earths, but also in extracting the gold disseminated in veins †, both in its native state, and mixed with iron pyrites, and with the grey copper ore. But the amalgamation of silver ores, and the ingenious process now used in the New World, to which we owe the greater part of the valuable metals existing in Europe, or which

* Plin. XXXIII. 6. Vetruv. VII. 8. Beckmann's Gesch. der Erfindungen, B. I. p. 44; B. III. p. 307; B. IV. p. 578.

† For example, at Goldcronach, in the Fichtelgebirge, where they still shew the situation of the old amalgamation mills (*quickmühlen*) for the braying of the auriferous minerals. Valuable documents have been found in the archives of Plasenbourg, which I had occasion to study during a long residence in the mountains of Steeben and Wunsiedel, that prove the antiquity of the amalgamation works at Goldcronach.

have flowed from Europe to Asia, goes no farther back than the year 1557. It was invented in Mexico by a miner of Pachuca of the name of Bartholome de Medina. From the documents preserved in the archives of the *despacho general de Indias*, and from the researches of Don Juan Diaz de la Calle *, there cannot remain a doubt as to the true author of the invention, which has sometimes been atrributed † to the canon Henrique Garces, who, in 1566, began to work the mercury mines of Huancavelica, and sometimes to Fernandez de Velasco, who in 1571 introduced the Mexican amalgamation into Peru. It is not so certain however, that Medina, who was born in Europe, had not already made experiments in amalgamation before coming to Pachuca. Berrio de Montalvo, an *alcalde de corte* at Mexico ‡, and author of a Memoir on the metallurgical treatment of silver ores, affirms, "that Medina had heard in Spain that silver might be extracted by means of mercury and common salt;" but this assertion is supported by no convincing proof. Cold amalgamation was found so profitable in Mexico, that in 1562, five years after the first discovery of the process of Medina, there were already 35 works at Zacatecas * in which minerals were treated with mercury, notwithstanding Zacatecas is three times further from Pachuca, than the old mines of Tasco, Zultipeque, and Tlapujahua.

The Mexican miners do not appear to follow any very fixed principle, in the selection of the ores submitted to smelting or amalgamation; for we see them smelt in one district of mines, the same mineral substances which in another they believe can only be managed with mercury. The ores which contain muriate of silver, for example, are sometimes smelted with carbonate of soda (*tequesquite*), and sometimes destined to the processes of hot and cold amalgamation; and it is frequently only the abundance of mercury, and the facility in procuring it, which determine the miner in the choice of his method. In general they find it necessary to smelt the very rich *meagre ores*, those which contain from ten to twelve marcs of silver per quintal, argentiferous sulphuret of lead, and the ores mixed of blende and vitreous cop-

* *Memorial dirigido al Señor Don Felipe IV.* (Madrid 1646) p. 49. *Garces, del beneficio de los metales*, p. 76—82.

† *Solorzano, Politica de las Indias*, lib. vi. c. vi. n. 17. *Garcilasso*, P. i. p. 225. *Acosta*, lib. iv. c. ii. *Lampadius Handbuch der Hüttenkunde*, B. i. p. 401.

‡ *Informe al Excellentiss Señor Conde de Salvatierra, virey de Mexico, sobre el beneficio descubierto por el Capitan Pedro Mendoza Melendez y Pedro Garcia de Tapia* (Mexico 1643) p. 19.

* *Descripcion de la ciudad de Zacatecas, por el Conde de Santiago de Laguna*, p. 42.

per. On the other hand, they find it profitable to amalgamate the *pacos* or *colorados* *, destitute of metallic lustre; native, vitreous, red, black, and horn-silver; fahlore rich in silver; and all the meagre ores which are disseminated in very small particles in the gangue.

The ores destined for amalgamation must be triturated, or reduced to a very fine powder, to present the greatest possible contact with the mercury. This trituration under the *arastras* or *mills*, of which we have already spoken, is of all the metallurgical operations that which is executed in the greatest perfection, in the most part of the Mexican works. In no part of Europe have I ever seen pulverized ores or powdered *schlich* so fine, and of so equal a grain, as in the great *haciendas de plata* of Guanaxuato, belonging to Count de la Valenciana, Colonel Rul, and Count Perez Galvez. When the ores are very pyritous, they are burnt (*quemar*) in the open air in *heaps*, on beds of wood, as at Sombrerete, or in *schlich* in reverberating furnaces (*comalillos*). The latter I found at Tehuilotepec: they are 12 metres † in length,

* *Alvaro Alonzo Barba, el arte de beneficiar metales* 1639, Lib. ii. c. iv. *Felipe de la Torre Barrio y Lima, minero de San Juan de Lucanas tratado de azogueria* (*Lima* 1738.) *Juan de Ordoñez, Cartilla sobre el beneficio de azogue* (*Mexico* 1758.) *Francisco Xavier de Soria, Ensayo de metalurgia* (*Mexico* 1784.)

† 38 feet. *Trans.*

without chimneys, but managed by two fires of which the flames traverse the laboratory. This chemical preparation of the ores is however very rare in general; the size of the fragments of substances to be amalgamated, and the want of combustibles on the table land of New Spain, render the process equally difficult and expensive.

The dry braying is done by *mazos*, eight of which work together, kept in motion by hydraulical wheels or by mules. The brayed ore (*granza*) passes through a hide pierced with holes; and it is reduced to a very fine powder under the *arastras* or *tahonas*, which are called *sencillas* or *de marco*, according as they are furnished with two or four blocks of porphyry or basalt (*piedras voladoras*), which revolve in a circle from 9 to 12 metres in circumference.* From 12 to 15 of these *arastras* or mills, are generally ranged in a row under one shed; and they are moved by water, or mules which are relieved every eight hours. One of these machines brays in the space of 24 hours, from three to four hundred kilogrammes† of ores. The humid *schlich* (*lama*) which leaves the *arastras*, is sometimes washed again in ditches (*estanques de deslamar*) the construction of which in the district of mines of Zacatecas,

* From 29 to 38 feet. *Trans.*

† From 662 to 882 lb. avoird. *Trans.*

has been recently carried to perfection by M. Garcès. When the ores are very rich, as in the mine of Rayas at Guanaxuato, they are only reduced under the stones of the mills to the size of coarse sand (*xalsonte*), and they separate, by washing, the richest metallick grains (*polvillos*), which are destined for smelting. This very economical operation is called *apartar polvillos*.

I have been assured, that in destining for amalgamation silver ores which are very poor in gold, they pour mercury into the vessel or trough, on the bottom of which the stones of the *arastras* turn; when the auriferous amalgamation goes on in proportion as the ore is reduced to powder: the rotatory motion of the *piedras voladeras* being favourable to the combination of the metals. I had no opportunity of seeing this operation, which is not practised at Guanaxuato. In some great amalgamation works of New Spain, the *arastras* are still unknown; they are contented with the braying of the *mazos;* and the *schlich* which comes from under them is passed through *sieves* (*cedazos* and *tolvas*). This comminution is very imperfect; a powder of an unequal and coarse grain amalgamates very ill; and the health of the workmen suffers greatly, in a place where a cloud of metallick dust is perpetually flying about.

The moistened *schlich* is carried from the

mills or *arastras*, into the court of amalgamation, (*patio* or *galera*) which is generally paved with flags. The flour is ranged in piles (*montones*) which contain from 15 to 35 quintals. Forty or fifty of these *montones* form a *torta*, by which name they call a heap of humid *schlich*, which they leave exposed to the open air, and which is frequently from 20 to 30 metres in breadth*, by five or six decimetres† in thickness. They use for amalgamation in a paved court, (*en patio*) which is the most generally used process in America, the following msterials; muriate of soda, (*sal blanca*) sulphate of iron and copper, (*magistral*), lime, and vegetable ashes.

The salt used in New Spain is of very unequal purity, according as it comes from the salt marshes which surround the port of Colima on the shores of the South Sea, or the famous *laguna del peñon blanco*, between San Luis Potosi and Zacatecas. This lake was visited by M. Sonneschmidt. It is situated at the foot of a granite rock, on the slope of the Cordilleras; and it dries up every year in the month of December. It furnishes annually to the revenue nearly 250 thousand *fanegas* of impure or earthy salt (*sal tierra*), which is

* From 65 to 98 feet. *Trans.*

† 19½ or 23½ inches. *Trans.*

all sold to the amalgamation works. On the spot even the price of a fanega is half a piastre. The districts of mines of the intendancy of Mexico, receive salt from the coast of Vera Cruz, and the springs of Chautla; and at Tasco the muriate of soda of Vera Cruz, sells for four piastres the quintal.

The *magistral* is a mixture of copper pyrites, (*kupferkies*) and sulphuret of iron, roasted for some hours in a reverberating furnace, and slowly cooled. If it is roasted longer, it produces an acid sulphate of iron and copper, mixed with iron oxidated to the *maximum*. Sometimes*, though seldom, the *azogueros* (the name given to the persons charged with the amalgamation) add to the pyrites, during their roasting muriate of soda; so that there is formed sulphate of soda, and muriate of copper and iron. I have also seen vitriolic earths, or copperas, (*tierras de tinta o de alcaparosa*), which are ochreous earths containing iron oxidated to the *maximum*, and sulphate of iron, mixed with the magistral. In the district of mines of Real de Moran, they employ in the preparation of the magistral, copper pyrites of San Juan Sitacora, the *carga* of which is paid for at the rate of ten piastres. The lime is obtained by calcinating very pure limestone, and slaking it with water; and

* *Garces*, p. 90.

very rarely alkaline ashes are substituted for calcined lime.

It is by the contact of these different substances, namely, moistened metallick powder, mercury, muriate of soda, sulphates of iron and copper, and lime, that the amalgamation of silver, in the process of cold amalgamation, (*de patio y por cruto*) takes place. They begin at first by mixing salt with the metallick powder, and they stir (*repassar*) the paste (*torta*). According to the purity of the salt used, they give each quintal of *schlich*, a quantity which varies from two and a half to twenty four pounds. If the muriate of soda is of moderate purity, they take from three to four per cent. They call *metales salineros*, those which are believed to require a great deal of salt, and in which the silver mineral is found in grains of considerable volume. They leave the mineral mixed with salt (*metal ensalmorado*) for several days, in order that the latter may dissolve and be equally distributed. If the *azoguero* judges the metals to be *warm*, (*calientes*), that is to say in a state of oxidation, and naturally charged either with sulphates of iron and copper which rapidly decompose in the air, or with muriate of silver, he adds lime to *cool* the mass; and this operation is called *curtir los metales con cal*. But the use *magistral*, if the *schlich* appears too cold (*frios*); for example, if they

proceed from ores which display great metallick lustre; if they contain sulphate of lead (*negrillos agalenados*), or pyrites difficult to decompose in the humid air; and this operation is called *curtir con magistral.* They attribute to the sulphate of iron and copper, the property of *heating* the mass; and they only consider it as well prepared, when, moistened and held in the hand, it causes a sensation of heat. In this case, the sulphuric acid which is concentrated in the acid sulphate, attracts the water and combining with it gives out caloric.

We have described two processes of chemical preparation of minerals, *salting* (*el ensalmorar*) and the manner of *tanning* (*curtir*) with lime or magistral. After the interval of some days they begin to *incorporate* (*incorporar*) the mercury with the metallick powder. The quantity of mercury is determined by the quantity of silver which they think will be drawn from the minerals; and they generally employ in the incorporation, (*en el incorporo*) six times the quantity of mercury which the *paste* contains of silver. They allow from three to four pounds of mercury for a marc of silver; and with the mercury or shortly afterwards, they add to the mass, magistral, according to the nature, or (to use the barbarous language of the *azogueros*) according to the *temperature* of the minerals (*segun los grados*

de frialdad). They allow from one to seven pounds of magistral to each pound of mercury; and if the mercury assumes a lead colour (*color aplomado,*) it is a mark that the paste is working, or that the chemical action has begun. To favour this action, and to augment the contact of the substances, they stir the mass (*se da repasso*) either by causing about twenty horses or mules to run round for several hours, or by setting workmen to tread the *schlich*, who for whole days go about barefooted in this metallick mud. Every day the *azoguero* examines the state of the powder; and he makes the trial (*la tentadura*) in a small wooden trough (*xicara*) that is to say, he washes a portion of *schlich* with water, and judges from the appearance of the mercury and the amalgam, if the mass is *too cold* or *too warm.* When the mercury takes an ash colour (*en lis cenicienta*); when a very fine grey powder is separated from it which sticks to the fingers, they say the paste is too *hot;* and they cool it by the addition of lime. But if, on the other hand, the mercury preserves a metallick lustre; if it remains white, and covered with a reddish or gilt pellicle (*telilla roxiza* o de *tornasol morado* or *en lis dorada*); if it does not appear to act upon the mass, the amalgamation is then considered to be too *cold*, and they endeavour to *heat* it (*calentar*) by a mixture of magistral.

In this manner, during the space of two, three and even five months, the *paste* is balanced between the *magistral* and the line; for the effects are very different according to the temperature of the atmosphere, the nature of the ores, and the motion given to the schlich. If they imagine that the action is too strong, and that the mass is working too much, they allow it to repose: or if they wish to accelerate the amalgamation, and increase the heat, they repeat oftener the stirring, sometimes employing men, and sometimes mules. If the amalgamation is formed too quickly, and appears in the form of small globules, called *pasillas* or *copos*, they feed the *paste* (*si ceba la torta*), by again adding mercury with a little magistral, and sometimes with salt. When from the exterior characters, the *azoguero* judges that the mercury has united with the whole silver contained in the ores, and that the *paste* has *yielded* (*ha rendido*), the metallick muds are thrown into vats of wood or stone. Small mills provided with sails placed perpendicularly, turn round in these vats. These machines (*tinas de cal y canto*) which are particularly well executed at Guanaxuato, have a resemblance to those established at Freiberg for washing the remains of the amalgamation.*

* *Fragoso de Sequeira, Description de l'amalgamation de Freiberg*, 1800, p. 36.

The earthy and oxidated parts are carried away by the water, while the amalgam and the mercury remain in the bottom of the vat. As the force of the current carries away at the same time some globules of mercury, in the great works, poor Indian women are employed in gathering this metal from the water used in washing. They separate the amalgam collected at the bottom of the *tinas del lavadero* from the mercury, by pressing it through sacks; and they mould it into pyramids which they cover with a reversed crucible in the shape of a bell. The silver is separated from the mercury by means of distillation. In the process which I have been describing, they lose in general from eleven and twelve to fourteen ounces of mercury for each marc of silver which they extract, that is to say, from $1\frac{7}{10}$ to $1\frac{7}{10}$ kilogrammes of mercury, for a kilogramme of silver. In the process of amalgamation introduced into Saxony, by M. M. Gellert and Charpentier, the consumption of mercury is $\frac{7}{10}$ of a kilogramme per kilogramme of silver, or eight times less than the proportion used in Mexico.*

* In an ordinary year they amalgamate at the work of Halsbrücke, near Freiberg, from 58 to 60 thousand quintal of meagre minerals, which *contain* from seven to eight *lots* of silver per quintal (two *lots* are equal to one ounce). The waste of mercury in amalgamation properly so called (*im an-*

We have described the cold amalgamation (*por crudo y de patio*), without roasting the ores, and by exposing them in a court to the open air. Medina was only acquainted with the use of salt, and sulphates of iron and copper; but in 1586, fifteen years after his process was introduced into Peru, Carlos Corso de Leca, a peruvian miner* discovered the *beneficio de hierro*. He advised the mixture of small plates of iron with the metallick powder, affirming that by this mixture more then nine tenths of the mercury would be saved. This process, as we shall afterwards see, is founded on the decomposition of the muriate of silver by the iron, and on the attraction of this metal for the sulphur. It is now but very little followed by the Mexican *azogueros*. In 1590, Alonzo Barba proposed the hot amalgamation in copper vats. This process is called the *beneficio de cazo y cocimiento;* and it is that which was

quicken) and in washing the remains, is three quarters of an ounce (or a lot and a quarter) per quintal of mineral. In the evaporation of the mercury (*ausglühen*), they waste a quarter of a lot of mercury, for a quantity of silver corresponding to a quintal of ore. Hence according to M. Heron de Villefosse, for every 60,000 quintals of ores, they consume or *destroy* 25½ quintals of mercury, (*Lampadius*, B. ii. p. 178.).

* *Carta de Don Juan Carbajal y Sandi presidente de la real audiencia de la Plata, al excellentis. Señor Conde de Chinchon, virey del Peru*, 1736.

proposed by M. Born, 1786. The loss of mercury is much less by it than in the *beneficio por patio*, because the copper of the vessels serves to decompose the muriate of silver, while at the same time the heat favours the operation, either in rendering the action of the affinities more energetic, or in giving motion to the liquid mass which enters into ebullition. This hot amalgamation is used in several of the mines of Mexico, which abound in *horn-silver* and *colorados*. Juan de Ordoñez, whose work has been already quoted, even advised amalgamation by means of stoves. In 1676, Juan de Corrosegarra, discovered a process which is very much in use at present, called the *beneficio de la pella de plata;* and in which silver already formed is added to the mercury of the amalgam. It is said, that this amalgam (*pella*) favours the extraction of the silver, and that the loss of mercury is so much less, as the amalgam disseminates itself with greater difficulty into the mass. A fifth method is the *beneficio de la colpa*, in which, instead of an artificial *magistral*, which contains much more of the sulphate of copper than the sulphate of iron, they use *colpa*, which is a natural mixture of acid sulphate of iron and iron oxidated to the *maximum*. This *beneficio de la colpa*, extolled by Don Lorenzo de la Torre, offers part of the advantages which we have just

pointed out in speaking of the amalgamation by iron.

The process invented by the miner of Pachuca, is one of those chemical operations, which for centuries have been practised with a certain degree of success, notwithstanding the persons who extract silver from ores by means of mercury, have not the smallest acquaintance either of the nature of the substances employed, or the particular mode of their action. The *azogueros* speak of a mass of ores as of an organized body, of which they augment or diminish the natural heat. Like physicians who in ages of barbarism, divided all aliments and all remedies into two classes, hot and cold, the *azogueros* see nothing in ores, but substances which must be heated by sulphates if they are too cold, or cooled by alcalies if too warm. The custom which was already introduced in the time of Pliny, of rubbing metals with salt, before applying the amalgam of gold, has undoubtedly given rise to the use of muriate of soda in the process of Mexican amalgamation. This salt, according to the accounts of the *azogueros*, serves to clean (*limpiar*, *castrar*) and to unskin (*desenzurronar*) the silver, which is enveloped with sulphur, arsenic, and antimony, as with a skin (*telilla* or *capuz*), whose presence prevents the immediate contact of the silver with the mer-

cury. The action of this last metal is rendered more energetic by the sulphates with which the mass is heated; and it is even probable that Medina only employed simultaneously, the sulphate of iron and copper, and the muriate of soda, because he discovered in these first attempts, that salt was only favourable to the process in the ores which contained decomposed pyrites. Without having any clear idea of the action of the sulphates on the muriate of soda, he endeavoured to *recompose* (*refaire*) the ores, that is to say, to add magistral to those which the miner considers as *not vitriolic*.

Since the practice of amalgamation of silver ores was introduced into Europe, and since the learned of every nation met at the metallurgic congress of Schemnitz*, the confused theory of Barba, and the Mexican *azogueros*, has been succeeded by sounder ideas, better adapted to the present state of chemistry. It is supposed that the practice of Freiberg, where a mass of roasted ores is amalgamated in a very few hours, will be gradually introduced into the amalgamation of Mexico, where the ores are generally not roasted, and where they remain exposed in the open air to the sun and the rain for several months. It is believed that in the moistened mixture of ores of silver and mercury, salt,

* Properly Szkleno or Glashütte, near Schemnitz.

lime and *magistral*, this last, which is an acid sulphate of iron and copper, decomposes the muriate of soda; that sulphate of soda and muriate of silver are formed, and that the latter is decomposed by the mercury which unites with the deoxidated silver. It is admitted that the lime or the potash, are added to prevent the superabundant sulphuric acid from acting on the mercury. According to this explanation, the silver which is found in its ore in the metallick state, though united with sulphur, antimony, iron*, copper, zinc†, arsenic‡, and lead§, passes into the state of muriate before combining with the mercury.

M. Garces‖ a Mexican author, whom we have frequently had occasion to quote, thinks on the other hand, that no muriate of silver is formed in the process of amalgamation. He supposes that the muriatic acid only combines with metals which are found united with silver: that water carries off the soluble muriates of iron and copper, and that silver freed from these metallick substances, combines freely with the

* In prismatic black silver. *Klaproth's Beiträge*, t. i. p. 166. *Bergbaukunde* b. i. p. 239.

† In *fahlore*, *weissgültigerz* and *graugültigerz*, *Klaproth*, t. iv. p. 61.

‡ In fahlore or argentiferous grey copper.

§ In *weisgültigerz*.

‖ *Teorica del Beneficio*, p. 112—116.

mercury. But this explanation, apparently very simple, is contrary to the laws of affinity. If muriatic acid, disengaged by the action of sulphates on the muriate of soda, were to act on any silver ore whatever, for example, on prismatic black silver, which contains silver, iron, antimony, sulphur, copper, and arsenic, muriate of silver would necessarily be formed whenever the acid should have exhausted the other metals. The theory of M. Garces is equally inapplicable to the amalgamation of sulphuretted silver ores, which are abundantly spread throughout the most part of the veins of Mexico.

Without entering in this work into any profound discussion of the phenomena, presented by the contact of so many heterogeneous substances; and without resolving the important question, whether cold amalgamation can be carried on without salt and without magistral, I shall confine myself to the mention of several experiments made by M. Gay-Lussac, and myself, which may tend to throw some light on Mexican amalgamation.

It is not true that the mixture of sulphur, entirely prevents the silver from uniting with the mercury, and that a sulphuret of silver only gives cold amalgam, in adding muriate of soda and sulphate of iron: we oberved, on the contrary, that on triturating mercury and artificial

sulphuret of silver, the mercury is quickly extinguished, and that a small quantity of silver is obtained by the distillation of the amalgam. We mixed mercury with vitreous silver ore reduced to powder; and after a contact of 48 hours, there was formed a small quantity of silver amalgam. In this experiment and in the following, we acted on two or three grammes* of mineral, the temperature of the air being from ten to twelve centigrade degrees†, and the mixtures having been slightly moistened.

On imitating the amalgamation *de patio* used in Mexico, and mixing in a cold state native sulphuret of silver, sulphate of iron, muriate of soda and lime, we did not find a vestige of muriate of silver, although the mixture remained in contact for a week; but we obtained it when the mass was exposed for some hours to an artificial temperature of from 30° to 34° centigrade.‡ In the warm regions of New Spain, the *tortas* exposed to the sun become the most heated, and it is observed that the amalgamation takes place a great deal slower on the table lands, where the thermometer descends to the freezing point, than in the deep vallies, and in the plains in the vicinity of the coast. It is probable that the muriate of silver

* 30 or 45 English grains. *Trans.*
† From 50° to 53° Fahr. *Trans.*
‡ From 86° to 93° Fahr. *Trans.*

which is promptly formed at a temperature of 34°, would form in a long space of time at a much lower temperature.

By mixing muriate of soda, sulphate of iron, and mercury in a cold state, we obtain muriate of mercury; and this muriate is also obtained when we triturate mercury with artificial muriate of silver. It is probable that in the process of amalgamation on a great scale, a part of the mercury is converted into muriate by two distinct ways, viz. by the decomposition of the muriate of silver, and by the immediate action of the magistral and salt employed in too great abundance. The lime which remedies the latter mode of action does not without the application of heat deprive the silver of its sulphur, for on mixing native sulphuret of silver with lime, no sulphuret of lime is formed, though the mixture have been triturated for several days. The lime opposes, in a very remarkable manner, the combination of silver with mercury. We observe that the latter is subdued with difficulty, when we triturate a mixture of lime, sulphuret of silver, and mercury. In the same manner on forming a paste of silver ores, salt, magistral, and mercury, and triturating the whole till the mercury becomes invisible, we see this last metal separate from the metallick powder, and unite in considerable masses whenever lime is added. Globules of mercury, which gradually

increase in size, appear wherever the particles of lime have touched the mixture; and it is from this peculiar action of the lime, that the *azogueros* assert it *cools* the mercury, or *prevents the paste* from *working*.

The muriatic acid, disengaged from the muriate of soda by the sulphate of iron, attacks the silver, although the latter is found in its ore in the metallick state. On treating vitreous silver with muriatic acid, we obtain muriate of silver in abundance; and on pouring the same acid on native sulphuret of silver, sulphuretted hydrogen is disengaged. M. Proust observed that the piastres which fell to the bottom of the sea, at the time of the memorable shipwreck of the San Pedro Alcantara, were covered in a short space of time with a crust of muriate of silver of half a millimetre * in thickness; and I made the same observation during my stay in Peru at the time of the shipwreck of the frigate Santa Leocadia on the South Sea coast near Cape Saint Helen. M. Pallas affirms † that on the banks of the Jaik in Siberia, old Tartar coins have been found converted into muriate of silver by the contact of an earth which is impregnated with muriate of soda. All these facts tend to prove that in many circumstances, muriatick acid acts upon metallick silver.

* .0196 of an inch. *Trans.*

† Nordische Beiträge, b. iii. p. 64.

M. Gay-Lussac and myself succeeded completely in imitating on a small scale the *beneficio de hierro*, an ingenious process known in Peru since the end of the sixteenth century, and introduced by M. Gellert into Saxony. We perceived that on mixing in a cold state, native sulphuret of silver, salt, *magistral*, lime and mercury, the amalgam formed in greater abundance when we added to the *paste* filings of iron. In this case the iron not only serves to decompose the muriate of silver, as in the process of amalgamation of Freiberg, but also to separate the sulphur from the mineralised silver. Leaving in contact for 24 hours sulphuretted silver and filings of iron, the silver was put into such a naked state that we obtained in a few minutes a considerable quantity of silver amalgam. If we pour muriatic acid on the mixture, infinitely more sulphuretted hydrogen is disengaged than we obtain on treating with the same acid sulphuretted silver alone. It is probable that the oxide of iron at the *maximum*, which is found in the *colorados* or *pacos*, and in ores mixed with decomposed pyrites, acts in a manner analogous to the filings of iron.

The enormous waste of mercury which we observe in the American process of amalgamation proceeds from several causes which act simultaneously. If in the process *por patio* all

the silver extracted were owing to a decomposition of muriate of silver by mercury, there would be lost a quantity of mercury which would be to that of the silver in the muriate, nearly as 4 : 7. 6 ; for this ratio is that of the respective oxidations of the two metals. Another and perhaps the most considerable part of the mercury is lost, because it remains disseminated in an immense mass of the moistened powder (*schlich*) ; and this division of the metal is so great, that the most careful washing is not sufficient to unite the particles concealed in the residue. A third cause of the loss of the mercury must be sought for in its contact with the salt water, in its exposure to the open air and the rays of the sun for the space of three, four and even five months. These masses of mercury and schlich which contain a great number of heterogeneous metallic substances, moistened by saline solutions, are composed of an infinite number of small *galvanic piles*, of which the slow but prolonged action is favourable to the oxidation of the mercury, and the play of chemical affinities.

It results from these researches, that the use of fire will sensibly improve the process of amalgamation. If the minerals to be treated are only vitreous silver, iron filings alone would be perhaps sufficient to lay the silver bare, and

separate it from the sulphur which retards its union with the mercury. But as in all the other silver ores there are besides sulphur different metals combined with the silver, the simultaneous employment of muriate of soda, and sulphates of copper and iron, becomes necessary to favour the disengagement of the muriatic acid which combines with the copper, iron, antimony, lead and silver. The muriates of iron, copper, zinc, and arsenic, and even that of lead remain dissolved ; and the muriate of silver which is next to insoluble is decomposed by contact with the mercury.

It has been long proposed to cover the surface on which the *torta* is prepared with plates of iron and copper instead of flags ; and it has been endeavoured to stir, (*repassar*) the mass by working it with ploughs of which the share and coulter should be made of the metals which we have been mentioning ; but the mules suffered too much from this work, the *schlich* forming a thick and by no means ductile paste. The custom of treading the *schlich* by mules instead of men was only introduced into Mexico in the year 1783. Don Juan Cornejo brought from Peru the idea of this process ; and the government granted him a privilege for it, which he did not long enjoy, and which only brought him in the sum of 300,000 livres tour-

mated; but in New Spain the quantity is nearly ten millions of quintals; and how is it possible to contain this enormous mass of minerals in tubs? How can we find sufficient power to turn a million of these casks or tubs? * How shall we roast the ores of a country which wants combustibles, and where the mines are on table lands destitute of forests?

After treating of the amalgamation in use in America, it remains for us to touch upon a very important problem, that of the quantity of mercury annually required by the mines of New Spain. Mexico and Peru depend very much upon the abundance and low price of the mercury for the quantity of silver which they produce. When the mercury fails them, which happens often in periods of maritime war, the mines are not so briskly worked; and the mineral accumulates in their hands without their being able to extract the silver from it. Rich proprietors, who possess in their magazines ores to the amount of two or three millions of francs, are frequently in want of the necessary money to make head against the daily expenses of their mines. On the other hand the more mercury is wanted in Spanish America, either on account of the flourishing state of the mines, or the process of amalgamation followed there, the more the price of this metal rises in Europe. The small number of countries which nature has supplied with it, Spain, the department of Mont-Tonnerre, Carniola, and Transylvania, gain by this rise; but the districts of silver mines in which the process of amalgamation is the more desirable, as they are in want of the necessary combustibles for smelting, feel very disadvantageously the effect of the great importations of mercury into America.

* It would undoubtedly require a million of casks to receive at once the 17 quintals of minerals; but supposing that we could amalgamate as rapidly as in Saxony, 3330 tubs would be sufficient to supply the place of the *beneficio del patio* of all Mexico. *Trans.*

New Spain consumes annually 16,000 quintals of mercury. * The court of Madrid having reserved to itself the exclusive right of selling mercury, both Spanish and foreign, entered in 1784, into a contract with the Emperor of Austria, by which the latter was to furnish mercury at a price of 52 piastres. The court sends annually in time of peace, by vessels of the Royal Navy, sometimes 9000, and sometimes 24,000 quintals. In 1803, a very useful project was formed of supplying Mexico for several years, in order that in the unforeseen case of a war, the amalgamation should not be impeded by the want of mercury; but this pro-

* 2,100,212 lb. troy. *Trans.*

ject (*del requesto*) shared the fate of so many others which have never been executed. Before 1770, when the working of mines was far from being so considerable as at present, New Spain received no other mercury but that of Almaden and Huancavelica. The German mercury furnished by the Austrian government, of which the greatest part is from Idria, was only introduced into Mexico after the falling in of the subterraneous works of Huancavelica, at a time when the mine of Almaden was inundated in the greatest part of its works *, and yielded only a very inconsiderable produce. But in 1800 and 1802, this last mine was again in such a flourishing state, that it could alone have furnished more than 20,000 quintals of mercury per annum, and there were sufficient grounds to conceive the hope of not having any necessity of recurring to German mercury, for supplying Mexico and Peru. There have been years, when ten or twelve thousand quintals of this last mentioned mercury, have been imported at Vera Cruz. Upon the whole, from 1762 to 1781, the amalgamation works of New Spain, destroyed the enormous sum of 191,405 quin-

* For these mines and those of Almadenejos, see the interesting researches of M. Coquebert de Montbret, in the *Journal des Mines*, No. 17, p. 396.

tals *, of which the value in America amounted to more than 60 millions of livres tournois. †

When the price of mercury has progressively lowered, the working of the mines has gone on increasing. In 1590, under the Viceroy Don Luis de Velasco II., a quintal of mercury was sold in Mexico for 187 piastres. But in the 18th century, the value of this metal had diminished to such a degree, that in 1750, the court distributed it to the miners at 82 piastres. Between 1767 and 1776, its price was 62 piastres the quintal. In 1777, under the administration of the Minister Galvez, a royal decree fixed the price of the mercury of Almaden at 41 piastres, two reals, and that of Germany at 63 piastres. At Guanaxuato, these two sorts of mercury are increased by the expensive carriage on the backs of mules, from 2 to 2½ piastres per quintal. The king gains on the mercury of Idria, on account of the difference of the weight used in Germany and in Mexico, 23 per cent.; so that a *wise politician* ought to engage the mother country to *sell* it at a *cheaper* rate. According to an old custom, the miners of certain districts of mines, for example, those of Guanaxuato and Zacatecas, are allowed to purchase two thirds of

* 25,124,200 lb. Troy. *Trans.*

† 2,400,000*l.* Sterling.

Spanish mercury, and only one third of German mercury. Other districts are forced to take more of the mercury of Idria, than that of Almaden. As the former is the dearest, there is a repugnance to taking it, and the miners affect to consider it as impure.

The impartial distribution of mercury (*el repartimiento del azogue*) is of the greatest consequence for the prosperity of the mines of New Spain. So long as this branch of commerce shall not be free, the distribution should be entrusted to the *Tribunal de Mineria*, which is alone able to judge of the number of quintals, indispensably necessary to the amalgamation works of the different districts. Unfortunately, however, the viceroys and those persons who are about them, are jealous of the right of administering themselves this branch of the royal revenue. They know very well that to distribute mercury, and especially that of Almaden, which is one third cheaper than that of Idria, is conceding a favour; and in the colonies as every where else, it is profitable to favour the richest and most powerful individuals. From this state of things, the poorest miners, those of Tasco, Temascaltepec, or Copala, cannot procure mercury, when the great works of Guanaxuato and Real del Monte have it in abundance.

The *general superintendency* of the mines in Spain, is charged with the sale of the mercury in the colonies of America. The minister Don Antonio Valdes, conceived the whimsical and audacious project of regulating himself from Madrid, the distribution of mercury among the different mines of Mexico. For this purpose, he ordered the viceroy in 1789, to draw up statistical tables of all the mines of New Spain, and to send to Europe specimens of the veins which were worked. The impossibility of executing the order of the Minister was felt in Mexico; not a single specimen was ever sent to Madrid; and the distribution of the mercury remained as formerly entrusted to the viceroy of of New Spain.

The following table * proves the influence of the price of mercury on its consumption. The diminution of this price, and the freedom of trade with all the ports of Spain, have all contributed to the progress of mining.

Periods.	Price of a quintal of mercury.	Total consumption of mercury.
1762—1766	82 Piastres	35750 quintals.
1767—1771	62	42000
1772—1777	62	58000
1778—1782	41	59000

* Influxo del precio del azogue sobre su consumo, por Don Antonio del Campo Marin. (M. S.)

It was known in Mexico in 1782, that China possesses mercury mines; and it was imagined that nearly 15,000 quintals might be annually drawn from Canton. The Viceroy Galvez sent there a cargo of otter skins by way of exchange for the mercury; but this project however, wise in itself, was very badly executed. The Chinese mercury obtained from Canton and Manilla was impure and contained a great deal of lead; and its price amounted to 80 piastres the quintal. And even at this price only a very small quantity could be procured. Since 1793, that important object has been totally lost sight of; and yet it would be of importance again to attend to it, especially at a time when the Mexicans experience great difficulty in procuring mercury from the Continent of Europe.

From all the researches which I could make, the whole of Spanish America, namely, Mexico, Peru, Chili, and the Kingdom of Buenos Ayres, (for elsewhere the process of amalgamation is unknown) annually consume more than 25,000 quintals of mercury, of which the price in the Colonies amounts to more than 6,200,000 livres.* M. Heron de Villefosse, in an interesting table which contains the quantity of each metal extracted from the mines over the whole globe, estimates the mercury annually drawn from

* 240,800*l.* Sterling. *Trans.*

those of Europe, at 36,000 quintals. Hence, going on these data, we find that mercury is after cobalt the rarest of all metals, and that it is even twice as rare as tin.

What is the quantity of gold and silver actually produced by the mines of New Spain? And what are the treasures which since the discovery of America, the commerce of Mexico has poured into Europe and Asia. The details which I procured during my stay in the Spanish Colonies, from the registers of the mints of Mexico, Lima, Santa Fe, and Popayan, have enabled me to give more exact information with regard to the produce of the mines, than any which has hitherto been published. Part of the results of my researches have been already published in the works * of M. M. Bourgoing, Brongniart, Laborde, and Heron de Villefosse, to whom I was eager to make such communication immediately after my return to Europe.

The quantity of silver annually extracted from the mines of New Spain, as we have already seen, does not depend so much on the abundance and intrinsic riches of the ores, as on the facility with which the miners procure

* *Bourgoing*, Tableau de l'Espagne moderne, 4^{e} edit. t. ii. p. 215. *Brongniart*, Traité de Minéralogie, t. ii. p. 351. *Laborde*, Itinéraire de l'Espagne, 1re ed^{n}. t. iv. p. 383 & 504. *Heron de Villefosse*, de la richesse minérale, t. i. p. 249—255.

the mercury necessary for amalgamation. We are not therefore to be surprized that the number of marcs of silver converted into piastres, at the mint of Mexico, varies very irregularly. When from the effect of a maritime war or some other accident, the mercury has failed for a year, and the following year it has arrived in abundance, in that case a very considerable produce of silver succeeds to a very limited fabrication of money.

In Saxony, where the small quantity of mercury which is wanted for the process of amalgamation, is procured with sufficient facility, the produce of the mines of Freiberg is so admirably equal, that from 1793 to 1799, it was never below 48,300, and never above 50,700 marcs of silver. In that country, the great droughts which prevent the going of the hydraulic wheels, and the water from being drawn off, have the same influence on the quantity of silver delivered into the mint, as the scarcity of mercury in America.

From 1777 to 1803, the quantity of silver annually extracted from the Mexican ores, has almost constantly been above two millions of marcs of silver *, and from 1796 to 1799, it was 2,700,000 marcs †; while from 1800 to

* 1,312,633 lb. troy. *Trans.*
† 1,772,053 lb. troy. *Trans.*

1802, it remained below 2,100,000 marcs.* But we cannot by any means infer from these data, that the mining operations in Mexico have not been so flourishing latterly. In 1801, the gold and silver obtained amounted only to 16,568,000 piastres †; while in 1803, the coinage again amounted, on account of the abundance of mercury, to 23,166,906 piastres.‡

Abstracting the influence of accidental causes, we find that the mines and stream works of New Spain, actually produce on an average 7000 marcs of gold §, and 2,500,000 marcs of silver ‖, of which the mean value amounts altogether to 22 millions of double piastres. ¶

About twenty years ago, this produce was only from ten to sixteen, and thirty years ago, from eleven to twelve millions of piastres. In the beginning of the eighteenth century, the quantity of gold and silver coined at Mexico was only from five to six millions. The enormous increase in the produce of the mines observable in latter years is to be attributed to a great number of causes, all acting at the same time, and among which the first place assigned

* 1,378,264 lb. troy. *Trans.*
† 3,479,280*l.* Sterling. *Trans.*
‡ 4,865,050*l.* Sterling. *Trans.*
§ 4593 lb. troy. *Trans.*
‖ 1,640,000 lb. troy. *Trans.*
¶ 4,620,000 Sterling. *Trans.*

must be to the increase of population on the table land of Mexico, the progress of knowledge and national industry, the freedom of trade conceded to America in 1778, the facility of procuring at a cheaper rate the iron and steel necessary for the mines, the fall in the price of mercury, the discovery of the mines of Catorce and Valenciana, and the establishment of the *Tribunal de Mineria.*

The two years in which the produce of gold and silver attained its *maximum*, were 1796 and 1797. In the former, there was coined at the mint of Mexico, 25,644,000 piastres; and in the latter, 25,080,000 piastres. To judge of the effect produced by the freedom of trade, or rather from the cessation of the monopoly of the galleons, we have merely to remember that the value of the gold and silver coined at Mexico, was, from 1766 to 1778, 191,589,179 piastres, and from 1779 to 1791, 252,525,412 piastres; so that from 1778, the increase has been more than a fourth part of the total produce.

We find in the archives of the mint of Mexico, very accurate accounts of the quantity of gold and silver coined since 1690, from which I have framed the two following tables: the first indicates the value of the *gold and silver* expressed in double piastres, and the second exhibits the *quantity of marcs of silver* given in to the mint, and converted into piastres.

TABLE I.

Gold and silver extracted from the mines of Mexico, and coined at Mexico, from 1690 to 1803.

Years.	Value in piastres.	Years.	Value in piastres.	Years.	Value in piastres.	Years.	Value in piastres.
1690	5,285,580	1720	7,874,323	1750	13,209,000	1780	17,514,263
1691	6,213,709	1721	9,460,734	1751	12,631,000	1781	20,335,842
1692	5,252,729	1722	8,824,432	1752	13,627,500	1782	17,581,490
1693	2,802,378	1723	8,107,348	1753	11,594,000	1783	23,716,657
1694	5,840,529	1724	7,872,822	1754	11,594,000	1784	21,037,374
1695	4,001,293	1725	7,370,815	1755	12,486,500	1785	18,575,208
1696	3,190,618	1726	8,466,146	1756	12,299,500	1786	17,257,104
1697	4,459,947	1727	8,133,088	1757	12,529,000	1787	16,110,340
1698	3,319,765	1728	9,228,545	1758	12,757,594	1788	20,146,365
1699	3,504,787	1729	8,814,970	1759	13,022,000	1789	21,229,911
1700	3,379,122	1730	9,745,870	1760	11,968,000	1790	18,063,688
1701	4,019,093	1731	8,439,871	1761	11,731,000	1791	21,121,713
1702	5,022,550	1732	8,726,465	1762	10,114,492	1792	24,195,041
1703	6,079,254	1733	10,009,795	1763	11,775,041	1793	24,312,942
1704	5,627,027	1734	8,506,553	1764	9,792,575	1794	22,011,031
1705	4,747,175	1735	7,922,001	1765	11,604,845	1795	24,593,481
1706	6,172,037	1736	11,016,000	1766	11,210,050	1796	25,644,566
1707	5,735,032	1737	8,122,140	1767	10,415,116	1797	25,080,038
1708	5,735,601	1738	9,490,250	1768	12,278,957	1798	24,004,589
1709	5,214,143	1739	8,550,785	1769	11,938,784	1799	22,053,125
1710	6,710,587	1740	9,556,040	1770	13,926,320	1800	18,685,674
1711	5,666,085	1741	8,663,000	1771	13,803,196	1801	16,568,000
1712	6,613,425	1742	16,677,000	1772	16,971,857	1802	18,798,600
1713	6,487,872	1743	9,384,000	1773	18,932,766	1803	23,166,906
1714	6,220,822	1744	10,285,000	1774	12,892,074		
1715	6,368,918	1745	10,327,500	1775	14,245,286		
1716	6,496,288	1746	11,509,000	1776	16,463,282		
1717	6,750,734	1747	12,002,000	1777	21,600,020		
1718	7,173,590	1748	11,628,000	1778	16,911,462		
1719	7,258,706	1749	11,823,500	1779	19,435,457		

Total of gold and silver from 1690 to 1803 1,353,452,020 piastres.*

* £284,224,924 Sterling. *Trans.*

TABLE II.—Silver drawn from the mines of Mexico from 1690 to 1800.

Years.	Marcs of silver.	Ounces.	Ochavas.	Years.	Marcs of silver.	Ounces.	Ochavas.	Years.	Marcs of silver.	Ounces.	Ochavas.	Years.	Marcs of silver.	Ounces.	Ochavas.
1690	621,835	4	0	1710	789,480	7	3	1730	1,146,573	0	0	1750	1,554,000	0	0
1	731,024	5	2	1	666,598	2	4	1	992,926	0	0	1	1,486,000	0	0
2	629,732	6	7	2	783,932	3	2	2	1,026,643	0	0	2	1,603,000	0	0
3	329,691	4	6	3	763,279	0	5	3	1,177,623	0	0	3	1,364,000	0	0
4	687,121	1	0	4	731,861	4	1	4	1,000,771	0	0	4	1,364,000	0	0
5	470,740	3	2	5	749,284	4	1	5	932,001	1	6	5	1,469,000	0	0
6	375,366	7	3	6	767,969	1	6	6	1,296,000	0	0	6	1,447,000	0	0
7	524,699	5	6	7	794,204	0	5	7	955,545	7	2	7	1,474,000	0	0
8	390,560	5	4	8	843,951	6	3	8	1,116,500	0	0	8	1,500,893	3	4
9	412,327	7	1	9	853,963	4	0	9	1,005,963	0	0	9	1,532,000	0	0
1700	397,543	6	2	1720	926,390	7	6	1740	1,124,240	0	0	1760	1,408,000	0	0
1	472,834	4	5	1	1,113,027	4	7	1	1,016,962	0	0	1	1,386,000	0	0
2	590,900	0	1	2	1,038,109	5	7	2	962,000	0	0	2	1,189,940	2	3
3	715,206	3	0	3	953,805	5	5	3	1,014,000	0	0	3	1,385,298	7	4
4	685,532	5	1	4	926,214	3	3	4	1,210,000	0	0	4	1,152,063	5	6
5	558,491	2	2	5	867,037	1	2	5	1,215,000	0	0	5	1,365,275	7	7
6	726,122	0	5	6	996,017	1	6	6	1,354,000	0	0	6	1,318,829	4	1
7	674,709	2	5	7	956,833	7	7	7	1,412,000	0	0	7	1,225,307	6	2
8	675,012	7	6	8	1,085,711	1	7	8	1,368,000	0	0	8	1,444,583	1	6
9	613,428	4	7	9	1,037,055	7	5	9	1,391,000	0	0	9	1,404,564	0	4

Total in silver alone, from 1690 to 1800, 149,350,721 marcs. *

Years.	Marcs of silver.	Ounces.	Ochavas.
1770	1,638,391	5	6
1	1,506,255	2	2
2	1,996,689	1	1
3	2,227,442	6	1
4	1,516,714	5	5
5	1,675,916	0	7
6	1,936,856	6	2
7	2,428,613	4	1
8	2,334,765	7	2
9	2,199,548	6	6
1780	1,994,073	4	7
1	2,311,062	3	0
2	2,014,545	1	1
3	2,709,167	0	3
4	2,402,965	7	7
5	2,111,263	7	0
6	1,978,844	5	6
7	1,819,141	1	3
8	2,293,555	5	3
9	2,415,821	2	1
1790	2,045,951	6	6
1	2,363,867	5	3
2	2,724,105	3	6
3	2,747,746	4	3
4	2,488,304	1	0
5	2,808,380	1	0
6	2,854,072	6	4
7	2,818,248	4	4
8	2,697,038	2	2
9	2,473,542	2	7
1800	2,098,712	5	1

* 98,008,212 lb. Troy. *Trans.*

It appears from these tables that the mines of New Spain have produced from 1690 to 1800, the enormous sum of 149,350,721 marcs of silver *; and from 1690 to 1803, gold and silver to the value of 1,353,452,020 double piastres †, or 7,105,623,105 livres tournois, estimating the piastres at 105 sous, French money.

For a hundred and thirteen years, the produce of the mines has been constantly on the increase, if we except the single period from 1760 to 1767. This increase becomes manifest, when we compare, every ten years, the quantity of the precious metals given in to the mint of Mexico, as is done in the following tables, of which the one indicates the value of the gold and silver in piastres, and the other, the quantity of silver in marcs.

* 98,008,212 lb. troy. *Trans.*

† 284,224,924*l.* Sterling. *Trans.*

Progress of the mining operations of Mexico.

Table I. *Gold and Silver.*

Periods.	Value of Gold and Silver in Piastres.
From 1690 to 1699	43,871,335
1700 1709	51,731,034
1710 1719	65,747,027
1720 1729	84,153,223
1730 1739	90,529,730
1740 1749	111,855,040
1750 1759	125,750,094
1760 1769	112,828,860
1770 1779	165,181,729
1780 1789	193,504,554
1790 1799	231,080,214
Total from 1690 to 1799 —	1,276,232,840

Table II. *Silver alone.*

Periods.	Silver.		
	Marcs.	Oz.	Oc.
From 1690 to 1699	5,173,099	2	7
1700 1709	6,109,781	5	2
1710 1719	7,744,525	2	6
1720 1729	9,900,203	7	7
1730 1739	10,650,546	1	0
1740 1749	12,067,202	0	0
1750 1759	14,793,893	3	4
1760 1769	13,279,863	4	1
1770 1779	19,461,194	6	1
1780 1789	22,050,440	6	7
1790 1799	26,021,257	6	3
Total from 1690 to 1799	147,252,008	6	6

When we distinguish those periods in which the progress of mining has been most rapid, we find the following results:

Periods.	Value of Gold and Silver, for an average year, in Piastres.	Progressive increase.	
			Piastres.
1690—1720	5,458,830	In 27 years	3,700,000
1721—1743	9,177,768		
1744—1770	11,854,825	25	2,000,000
1771—1782	17,223,916	19	5,300,000
1783—1790	19,517,081	12	2,300,000
1791—1803	22,325,824	10	2,800,000

This table, along with the preceding one, proves that the periods during which the wealth of the mines have most increased, are from 1736 to 1745, from 1777 to 1783, and from 1788 to 1798; but the increase in general has been so little in proportion to the space of time, that the total produce of the mines was:

4 millions of piastres in 1695
8 - - 1726
12 - - 1747
16 - - 1776
20 - - 1788
24 - - 1795

from whence it follows that the produce has

been tripled in fifty-two years, and sextupled in a hundred years.

After the gold and silver, it remains for us to speak of the other metals, called common metals, the working of which, as we have already stated in the beginning of this chapter, has been very much neglected. *Copper* is found in a native state, and under the forms of vitreous and oxidulated copper, in the mines of Ingaran, a little to the south of the Volcano of Jorullo, at San Juan Guetamo, in the intendancy of Valladolid, and in the province of New Mexico. The Mexican *tin* is obtained by means of washing, from the alluvial soil of the intendancy of Guanaxuato, near Gigante, San Felipe, Robledal and San Miguel el Grande, as well as in the intendancy of Zacatecas between the towns of Xeres and Villa Nueva. One of the ores of tin most common in Mexico is the *wood tin* of the English mineralogists. It appears that this mineral is originally found in veins which traverse trap-porphyries; but the natives, instead of working these veins, prefer the extracting of tin from the earth brought down the ravins. The intendancy of Guanaxuato in 1802, produced nearly 9200 *arrobas* of copper, and 400 of tin.

The *iron* mines are more abundant than is generally believed, in the intendancies of Valladolid, Zacatecas, and Guadalaxara, and especially in the *provincias internas*. We

have already explained* the reason why these mines, the most important of all, are only wrought with any degree of spirit during a period of maritime war, when a stop is put to the importation of steel and iron from Europe; and we have already named the veins of Tecalitan, near Colima, which were successfully wrought ten years ago, and afterwards abandoned. Fibrous magnetic iron-stone is found in conjunction with magnetic pyrites in veins which traverse *gneiss* in the kingdom of Oaxaca. The western slope of the mountains of Mechoacan abounds in ores of compact red iron-stone and brown hematite. The former have also been observed in the intendancy of San Luis Potosi near Catorce. I saw crystalized micaceous iron, near the village of Santa Cruz, east from Celaya, on the fertile table land extending from Queretaro to Guanaxuato. The Cerro del Mercado, situated near the town of Durango, contains an enormous depot of ores of brown, magnetic, and micaceous iron. I enter into the detail of these localities for the sake of proving the falsity of the opinion delivered by several modern natural philosophers, that iron almost exclusively belongs to the most northern regions of the temperate zone. To

* See p.106 of this volume.

M. Sonneschmidt we owe the knowledge of the meteoric iron *, which is found in several places of New Spain, for example, at Zacatecas, Charcas, Durango, and, if I am not deceived, in the environs of the small town of Toluca.

Lead, which is very rare in the north of Asia, abounds in the mountains of calcareous formation, contained in the north-east part of New Spain, especially in the district of Zimapan, near the Real del Cardonal and Lomo del Toro; in the kingdom of New Leon, near Linares; and in the province of New Santander, near St. Nicholas de Croix. The lead mines are not wrought with so much spirit as we could wish for in a country where the fourth part of all the silver minerals are smelted.

Among the metals, of which the use is the most limited, we have to name *zinc*, which is found, under the form of brown and black blende in the veins of Ramos,

* *Sonneschmidt*, p. 188 and 192. The mass of Zacatecas still weighed ten years ago, near 2000 lib. See a memoir of M. Chladni in the *Journal des Mines*, 1809, no. 151, p. 79, relative to a meteoric stone, which fell between Cicuic and Quivira, according to the testimony of Cardanus and Mercati. The geographical position of Cicuic and Quivira, names which recal to us the fables of El Dorado of South America, remains still unknown.

Sombrerete, Zacatecas, and Tasco; *antimony*, which is common to Catorce and los Pozuelos, near Cuencame; *arsenic*, which is found among the minerals of Zimapan, combined with sulphur, as orpiment. *Cobalt*, as far as I know, has never yet been discovered among the minerals of New Spain; and *manganese* *, which M. Ramirez recently discovered in the Island of Cuba, appears to me in general much less abundant in Equinoctial America, than in the temperate climates of the Old Continent.

Mercury, which is very remote from *tin*, with respect to its relative antiquity, or the period of its formation, is almost as uncommon as it, in every part of the globe. The inhabitants of New Spain have procured for centuries the mercury necessary in the process of amalgamation, partly from Peru, and partly from Europe; and hence they are accustomed to consider their country as destitute of this metal. However, when we consider the examinations carried on under the reign of Charles the 4th, we are forced to admit that few countries have so many indications of cinnabar, as the table land of the Cordilleras from the 19° to the 22° of north latitude. In the intendancies

* To the west of the town of Cuenca, in the kingdom of Quito, there exists earthy grey manganese, which forms a bed in sandstone.

of Guanaxuato and Mexico, we find it almost wherever pits are dug between San Juan de la Chica and the town of San Felipe; near Rincon del Centeno, in the environs of Celaya; and from Durasno, and Tierra Nueva to San Luis de la Paz, especially near Chapin, Real de Pozos, San Rafael de los Lobos, and la Soledad. Sulphuret of mercury has been also discovered at Axuchitlan and Zapote *, near Chirangangueo, in the intendancy of Valladolid; at los Pregones near Tasco, in the district of mines of the Doctor; and in the valley of Tenochtitlan to the south of Gassavé in the road from Mexico to Pachuca. The works carried on for the discovery of these different mineral repositories have been so frequently interrupted, and they have been conducted with so little zeal, and generally with so little intelligence, that it would be very imprudent to advance, as has been often done, that the mercury mines of New Spain are not worth the working. It appears, on the contrary, from the interesting information which we owe to the labours of M. Chovel, that the veins of San Juan de la Chica, as well as

* In the mines of San Ignacio del Zapote, where the cinnabar is constantly mixed with *blue carbonate of copper*, while at Schemnitz and Poratich in Hungary the *antimoniated grey copper* (graugültigerz) contains 0.60 mercury. *Klaproth*, iv. p, 65.

those of the Rincon del Centeno, and the Gigante, are very deserving of the attention of the Mexican miners. Was it to be expected that superficial works which were merely begun, should in the very first years yield a net profit to the shareholders?

The mercury mines of New Spain are of very different formations. Some are found in beds in secondary rocks, and others in veins which traverse trap porphyries. At Durasno, between Terra Nueva and San Luis de la Paz, cinnabar, mixed with a number of globules of native mercury, forms a horizontal bed (*manto*) which rests on porphyry. This *manto*, which has been pierced by pits of five or six metres* in depth, is covered with beds of slate-clay, which contains fossil wood, and coals. On examining the roof of the *manto*, we find from the surface, first a bed of *slate-clay* (*schieferthon*) impregnated with nitrate of potash, and containing fragments of petrified vegetables; then a stratum of slate-coal (*schieferkohle*) of a metre † in thickness; and lastly *slate-clay* which immediately covers the ore of cinnabar. From this mine there was drawn, eight years ago, in a very few months, nearly 700 quintals of mercury, which were

* 16 or 19 feet.

† 3.28 feet.

not sufficient to pay the expences of working, although the ore contained a pound of mercury for every load of three quintals and a half. The carelessness with which the mine of Durasno was wrought, has been so much the more prejudicial, as on account of the small degrees of solidity of the *rock of the roof*, and its horizontal position, it very frequently fell in. The mine is at present drowned, and to resume the operations would not be attended with profit. It has constantly enjoyed very high celebrity in the country, not on account of its wealth, which is inferior to that of the veins of San Juan de la Chica, but because it admitted of being wrought *sub dio*, and because its produce was very abundant. They attempted in vain to discover a second bed of mercurial ore below that of Durasno.

The cinnabar vein of San Juan de la Chica is two or three and sometimes even six metres in width. It traverses the mountain of *los Calzones*, and extends to Chichindara. Its ores are extremely rich, but by no means abundant; I have seen there masses of compact and fibrous cinnabar of a bright red, twenty centimetres in length, and three in thickness*; and these specimens resembled from their purity the richest produce of Almaden and

*7.87 inches by 1.18. *Trans.*

Wolfstein in Europe. The mine of Chica has been only yet wrought to the depth of fifty metres*; and it is found, and this geological fact is very remarkable, not in sandstone or slate, but in a true *pitchstone porphyry*, divided into balls with concentric layers, of which the interior is lined with mammillated hyalite (*müllerisch-glass*). The cinnabar and a little native mercury, are sometimes observed in the middle of the porphyritic rock at a very considerable distance from the vein. During my stay at Guanaxuato, only two mines were wrought in all Mexico; those of Lomo del Toro, near San Juan de Chica, and Nuestra Señora de los Dolores, a quarter of a league to the south-east of the Gigante. In the first of these mines a load of ore yields from two to three pounds of mercury; and the expences of working are very moderate. The mine of the Gigante, from which there is even drawn six pounds of mercury per load (*carga*) of ore, furnished from 70 to 80 pounds weekly; and it is wrought on the account of a rich individual, Don Jose del Maso, who has the merit of having first excited his countrymen during the last war to the working of the quicksilver mines, and the manufacture of steel. The cinnabar

* 164 feet. *Trans.*

extracted from the veins of the mountain del Fraile, near the *Villa de San Felipe*, occurs in a porphyry with base of hornstone, which, being traversed by veins of tin, is undoubtedly more antient than the *pitchstone porphyry* of Chica.

America in its present state is the tributary of Europe with respect to mercury; but it is probable, that this dependance will not be of long duration, if the ties which unite the Colonies with the mother country remain long loosened, and if the civilization of the human species in its progressive motion from East to West is concentrated in America. The spirit of enterprize and research will increase with the population; the more the country shall be inhabited, the more they will learn to appreciate the natural wealth which is contained in the bowels of their mountains. If they discover no single mine equal in wealth to Huancavelica, they will work several at once, by which the united produce will render the importation of mercury from Spain and Carniola unnecessary. These changes will be so much the more rapidly operated, as the Peruvian and Mexican miners shall feel themselves impeded by the want of the metal necessary for amalgamation. But let us enquire what would be the consequence to the silver

mines of America, if in the midst of the wars by which Europe is oppressed, the quicksilver mines of Almaden and Idria, should no longer be wrought.

I have mentioned the mineral depositories of New Spain, which if examined with care, and worked with constancy, may produce one day a very considerable quantity of mercury. The period approaches when the Spanish Colonies being more united together, will be more attentive to their common interests; and it becomes, therefore, of consequence to take a general view of the indications of mercury observable in South America. Mexico and Peru, instead of receiving this metal from Europe, will one day perhaps be able to supply the old world with it. I shall confine myself to the knowledge which I could obtain on the spot, and especially during my stay at Lima; and I shall only mention the points where cinnabar has been found, either in veins or beds. In several places, for example, at Portobello, and Santa Fe de Bogota, considerable quantities of native mercury have been collected at small depths in building houses; and this phenomenon has frequently fixed the attention of government. They forget that in a country where, for three centuries, bags filled with mercury have been transported on mules from province to province, this mercury

must necessarily have been scattered in the sheds, under which the beasts of burden are unloaded, and in the quicksilver magazines established in towns. The mountains in general contain mercury in its native state, in very small portions only; and when in an inhabited place, or on a great road, we discover in the earth several kilogrammes collected together, we must believe that these masses originated in accidental infiltrations.

In the kingdom of New Granada, cinnabar is known in three different places, namely, in the province of Antioquia, in the *Valle de Santa Rosa*, east from the Rio Cauca; in the mountain of *Quindiu*, in the pass of the central cordillera between Ibague and Carthago, at the extremity of the Ravin of Vermellon; and lastly, in the province of Quito, between the village of Azogue and Cuenca. The discovery of the cinnabar of Quindiu is due to the patriotic zeal of the celebrated traveller Mutis, who in the months of August and September, 1786, at his own expense, caused the miners of Sapo to examine that part of the granitic cordillera which extends to the South from the *Nevado* de Tolima towards the Rio Saldaña. The ore of sulphuret of mercury is not only found in round fragments mixed with small grains of gold in the alluvial earth with which the Ravin (*quebrada*) de Vermellon at the foot of the table land of *Ibague Viejo* is filled; but they know the vein also from which the torrent appears to have detached these fragments, and which traverses the small ravin of Santa Ana. Near the village of Azogue to the north-west of Cuenca, the mercury is found, as in the department of Mont-Tonnerre, in a formation of quartzy sandstone with argillaceous cement. This sandstone is nearly 1400 metres * in thickness, and contains fossil wood † and asphaltum. ‡ In the mountains of Guazun and Upar, situated to the north-east of Azogue, a vein of cinnabar traverses beds of clay filled with calcareous spar, and contained in sandstone. We discover there the remains of an old level of 120 metres in length §, and 11 pits very close to one another. It is believed in the country that this mine was wrought before Huancavelica, and that it was the discovery of the

* 4592 feet. *Trans.*

† I found beautiful pieces of 14 decimetres (4½ feet English) in length at Silcai-Yacu between Delec and Cuenca.

‡ At Porche and the western declivity of the mountains of Coxitambo, I was singularly struck with the geological relations between the sandstone formation of Cuenca and Azogue and the sandstone of the mines of Wolfstein and Münsterrappel, which I visited in 1790, and which also contain cinnabar, fossil wood, and petroleum.

§ 393 feet. *Trans.*

latter, which was the occasion of its abandonment. The learned experiments of Don Pedro Garcia, and the works executed by M. Vallejos, the intendant of Cuenca in 1792, have not proved that the vein of cinnabar of Guazun, may be successfully wrought. At five leagues distance from the town of Popayan, to the North-west near Zeguengue, there is a ravin which is called the mercury ravin (*quebrada del azogue*) without the origin of the name being known.

In Peru, cinnabar is found near Valdivui, in the province of Pataz, between the eastern bank of the Marañon and the missions of Guailillas; at the foot of the great *Nevado de Pelagato*, in the province of Conchucos, to the east of Santa; at the baths of Jesus, in the province of Guamalies to the south-east of Guacarachuco; near Huancavelica in the intendancy of that name; and near Guaraz, in the province of Guailas. From the account books found in the provincial treasury of the town of Chachapoyas (between the Rio Sonche and the Rio Utcubamba), it appears that at the beginning of the conquest, quicksilver mines were wrought in the moderately elevated mountains which extend from Pongo de Manseriche to near Caxamarquillo and the Rio Huallaga; but from the information which I obtained during my stay in the province of

Jaen, the place where these mines were situated is at present totally unknown. The veins of cinnabar of Guaraz were worked with some degree of success in 1802. There was extracted as much as 84 pounds of mercury from a mass of minerals of 1500 pounds weight.

The famous mine of Huancavelica, as to the state of which so many erroneous ideas have been disseminated, is in the mountain of Santa Barbara, to the south of the town of Huancavelica, at a horizontal distance of 2772 *varas* (or 2319 metres *). The height of the town above the level of the sea, is according to Le Gentil† 3752 metres (1925 toises)‡. If we add to this the 802 varas, which the summit of the mountain of Santa Barbara is higher than the level of the streets of Huancavelica, we shall find the absolute height of this

* 7606 feet. *Trans.*

† This height is calculated agreeably to the formula of M. La Place, supposing a temperature of 10 centigrade degrees (50° Fahr.) According to Le Gentil, (*Voyage aux Indes*, t. i. p. 76.) the mean height of the barometer at the town of Huancavelica is 18^{po}. 1^{li}. 5. In the manuscript of Mothes, this height is estimated at 18$^{p°}$. 7^{li}. which would give only 1814 toises, or 3535 metres of absolute elevation, (11,596 feet. *Trans.*) The great square of the town of Micuipampa, where I found the barometer 18^{po}. 4^{li}. 7, would then be 84 metres (275 feet. *Trans.*) higher than the level of the streets of Huancavelica. (*Recueil d'Observations Astronomiques*, vol. i. p. 316.)

‡ 12,308 feet. *Trans.*

mountain 4422 metres *. The discovery of the great quicksilver-mine, is generally attributed to the Indian Gonzalo Abincopa or Navimcopa; but it is certain that it goes back to a period long before 1567, since the Incas made use of cinnabar (*llimbi*) in painting themselves, and procured it from the mountains of Palcas. The working of the mine of the Cerro de Santa Barbara on account of the Crown, began however only in the month of September 1570, nearly the same year in which Fernandez de Velasco introduced the Mexican amalgamation into Peru.

Mercury is found in the environs of the town of Huancavelica, in two very different manners, in beds and in veins. In the great mine of Santa Barbara, the cinnabar is contained in a bed of quartzy sandstone of nearly 400 metres in thickness, and in a direction of hor. 10—11 of the German miner's compass, with an inclination of 64° towards the west. This sandstone, analogous to that of the environs of Paris, and the mountains of Aroma and Cascas, in Peru, resembles pure quartz. The most part of the specimens which I examined in the geological cabinet of the Baron de Nordenflycht, exhibit very little argillaceous cement. The quartz rock, which contains the mercurial ores, forms a bed in a calcareous breccia, from which it is only separated in its wall and its roof, by a very thin stratum of slate clay (*schieferthon*), which has been frequently confounded with primitive slate. The breccia is covered with a formation of secondary limestone, and the fragments of compact limestone contained in the breccia, seem to indicate that the whole mass of the mountain of Santa Barbara itself reposes on alpine limestone (*alpenkalkstein*). This last rock is in fact to be seen on the eastern slope of the mountain near Acobamba and Sillacasa. It is still found at very considerable elevations, and is of a bluish-grey, and traversed by a great number of small veins of calcareous spar. Ulloa observed there in 1761 petrified shells *, at a height of more

* 14,506 feet. *Trans.* This measurement agrees very well with the assertion of Ulloa, who relates that he saw the barometer remain at the bottom of the mine of Hoyo Negro at 17^{po}. 2^{li}. 2; from which we may conclude that the bottom of the mine was then 2159 toises, or 4208 metres of elevation above the level of the ocean (13,805 feet. *Trans.*) (*Ulloa, Noticias Americanas*, p. 279.) In this pit then the miners wrought in a point which is 500 metres (1640 feet) higher than the summit of the Peak of Teneriffe. In the Cerro de Hualgayoc, I have seen galleries of which the absolute height exceeded 4050 metres (13,287 feet. *Trans.*)

* We also found them on the ridge of the Andes, near Montan and Micuipampa; *Géographie des Plantes*, p. 127. See, as to the marine shells observed at great heights in Europe and America, *Faujas de Saint-Fond, Essai de Geologie*, t. ii. p. 61—69.

than 4300 metres.* M. de Nordenflycht also discovered pectinites and cardia in a bank of shells, between the villages of Acoria and Acobamba, near Huancavelica, at an elevation surpassing by more than 800 metres †, that of the bank of nummulites found by M. Ramond on the summit of Mont-Perdu.

The cinnabar by no means fills the whole quartz bed of the great mine of Santa Barbara; it forms particular strata; and sometimes it is found in small veins, which *drag* (*se trainent*) and unite in masses (*stockwerke*). Hence the metalliferous mass is only in general from 60 to 70 metres ‡ in breadth. Native mercury is extremely rare, but the cinnabar is accompanied with red iron ore, magnetic iron, galena, and pyrites; and the crevices are frequently variegated with sulphate of lime, calcareous spar, and fibrous alum (*feder-alaun*), with curvilinear parallel fibres. The metalliferous bed at great depths § contains a good deal of orpiment and realgar, or yellow and red sulphurets of arsenic. This mixture formerly occasioned the

* 14,107 feet. *Trans.*

† 2624 feet. *Trans.*

‡ From 196 to 229 feet. *Trans.*

§ Particularly below the depth of 230 varas (629 feet. *Trans.*) The Galena is found nearer the surface of the earth, and even 40 varas lower than the gallery of San Xavier.

death of many workmen, who wrought at the distillation of ores of cinnabar mixed with orpiment, till the government took the resolution of prohibiting the carrying on the works of Cochapata, in which arsenic abounds the most. I suppose that the vapour called *umpe*, of which the alarming effects are described by Ulloa, is arsenical hydrogen gas; but it has been much more rarely felt than might be believed, from the accounts of the Spanish travellers.

The great mine of Santa Barbara is divided into three stories, (*pertinencias*) which bear the names of *Brocal*, *Comedio*, *Cochapata*. The depth of the mine is 349 varas; and its total length from north to south 536 varas. It is reckoned that 50 quintals of tolerably rich ores, yield by distillation from 8 to 12 pounds of mercury. The mineral depository is worked by three galleries, viz. the *Socabon de Ulloa*, the *Socabon de San Francisco Xavier*, and the *Socabon de Nuestra Señora de Belem*, begun in 1615, and finished in 1642. The gallery cut by the astronomer Don Antonio Ulloa, who as governor of Huancavelica directed the works for some years, is only 75 varas in length; and its mouth is almost level with the great square of the town. It would require to be still prolonged 2000 varas, to traverse the *pertinencia de Cochapata*. It is the only gallery which

follows the direction of the metalliferous bed, for the two others were cut in the solid rock. The *Socabon de Belem*, the most useful of all these different works, is 625 varas in length, and cuts the mineral repository at the depth of 172 varas below the summit of the mountain of Santa Barbara. The gallery of San Xavier, finished in 1732, is 112 varas above the Socabon of Belem. All these galleries, which have cost immense sums, because they are more than five varas in breadth *, are merely for ventilation and interior conveyance; for the mine is absolutely free from water.

There has been extracted † from the great mine of Huancavelica, between 1570 and 1789, the sum of 1,040,452 quintals of mercury ‡; viz.

From	1570	to 1576	9,137 quintals.
	1576	1586	60,000
	1586	1589	31,500
	1590	1598	59,850
	1599	1603	20,000
	1604	1610	19,000
	1611	1615	30,000
	1616	1622	59,463
	1623	1645	96,600

* More than 13 feet. *Trans.*

† *Noticias sobre la mina de Huancavelica*, (M. S. note of M. Mothes.)

‡ 136,573,162 lb. Troy. *Trans.*

From	1646	to 1648	20,460 quintals.
	1648	1650	8,342
	1651	1666	109,120

According to this table, the quantity of mercury extracted from the great mine of Huancavelica, amounted, in the first 96 years, to the sum of 523,472 quintals. There has been obtained in the following periods,

From	1667	to 1672	49,026 quintals.
	1673	to 1683	60,000

We find no mention in the archives of the treasury, of the produce of the mine between 1684 and 1713; but it was

From	1713	to 1724	41,283 quintals.
	1725	1736	38,882
	1737	1748	65,426

From these data, it appears that the mine has generally yielded from four to six thousand quintals of mercury per annum. In the most abundant years, between 1586 and 1589, the produce amounted to 10,500 quintals.

Besides the cinnabar which is contained in the bed of quartzy sandstone, of the Cerro de Santa Barbara de Huancavelica, there is also some in this same part of the Cordilleras, especially near Sillacasa, in small veins which traverse the alpine limestone (*alpenkalkstein*); but these veins, which are frequently full of calcedony, do not follow regular directions; they cross and drag frequently, and form *nests*

or metallic depots.* For these fifteen years, all the mercury which Huancavelica supplies to the miners of Peru, is derived from these last mineral depositories, the metalliferous bed (*erzflöz*) of the great mine of Santa Barbara, having been completely abandoned, owing to the falling in which took place in the *pertinencia* of the *Brocal.* Avarice and carelessness were the cause of this unfortunate accident. So early as 1780, the directors of the mine had difficulty in furnishing the quantity of mercury required, for the continually increasing wants of the Peruvian amalgamation. The deeper the works became, the cinnabar grew also more impure, and mixed with sulphuret of arsenic. As the bed forms a mass of an extraordinary volume, it could only be worked by *longitudinal* and *transversal* † *galleries.* To support the roof, pillars were left from distance to distance, as is practised in the coal and salt mines. An intendant of Huancavelica, a lawyer, and a praise-worthy man in other respects for his knowledge and integrity, had the temerity to remove these pillars to increase the produce of the mine. This operation had the effect which every intelligent miner might have easily predicted; the rock, deprived of support,

* *Nidos, bolsas y clavos* (*Zusammen-scharende Trümmer*).

† *In quer und pfeiler-bau.*

yielded to the pressure; the roof tumbled in, and as this falling in took place in the greater part of the *upper* pertinencia, that of the Brocal, the works in the two inferior *pertinencias,* Comedio, and Cochapata, were also obliged to be given up. The master miners accused the intendant, of having removed the pillars to ingratiate himself with the Court of Madrid, by procuring in a very few years a great quantity of mercury. The intendant on his part affirmed that he had acted altogether with the consent of the master miners, who thought the pillars might be replaced by heaps of rubbish. Instead of taking a decisive part, and working the metalliferous bed in other points, they lost eight years in sending from time to time commissaries to the spot to carry on a lawsuit, and dispute about vain formalities. When I left Lima, they were waiting for a decision of the Court; the great mine was shut up; but they had given free permission to the Indians from 1795, to work the cinnabar veins which traverse the alpine limestone between Huancavelica and Sillacasa. The annual produce of these petty operations, amounted to 3200 or 3500 quintals. As by law, all the mercury must be delivered into the treasury (*caxas reales*) of Huancavelica, I shall give from the account books the produce between 1790 and 1800.

In 1790	- -	2021 quintals	37 pounds.
1791	- -	1795	69
1792	- -	2054	14
1793	- -	2032	68
1794	- -	4152	95
1795	- -	4725	47
1796	- -	4182	14
1797	- -	3927	32
1798	- -	3422	58
1799	- -	3355	92
1800	- -	3232	83

It has been asked whether in the present state of things it would be prudent to clear out the old works of the great mine *, or if they ought to engage in new trials. From the memoirs drawn up by the Baron de Nordenflycht, it appears to be absolutely false that the mine of Santa Barbara was exhausted when they were so imprudent as to remove the pillars. In the *pertinencia* de Cochapata, at 228 varas of depth, cinnabar ores have been found, equally rich with those of the Brocal; but as for ages, the works have been under the direction of ignorant men, destitute of all knowledge of subterraneous geometry, they have given the

* Before the year 1795, seven thousand alpacas and llamas led and governed by intelligent dogs carried the mercurial ores from the Cerro De Santa Barbara, to the furnaces supplied with *aludel*, which are situated near the town of Huancavelica.

work the form of a cylinder, whose axis is inclined from north to south. Near the surface in the Brocal, the metalliferous bed has scarcely ever been wrought on the south side; but on the other hand, in the depth at Cochapata, the galleries have been for a very small way carried northwards. This particular disposition of the works has given reason for believing the cinnabar is lost towards the bottom of the mine; but if it has been found in less abundance, it is because in going deeper and deeper towards the south, they gradually entered the sterile part of the bed of quartzy sandstone.

Notwithstanding the justness of these considerations, it seems by no means prudent to advise the clearing out of the old mine; for this operation must require an immense expense, and the old works were so badly disposed that it is impossible to derive any advantage from them. The metalliferous bed of the Cerro de Santa Barbara extends many leagues beyond Sillacasa, even as far as above the village of Guachucalpa; and by beginning to work on points which have hitherto remained untouched, there would hardly be a doubt of the success of the operations; for nothing can be a stronger proof of the abundance of the mercury in this part of the Cordilleras, than

the produce of the petty labours of the Indians. If small veins of cinnabar merely uncovered at their surface, yield annually, on an average 3,000 quintals, we cannot entertain a doubt that *works of investigation* directed with intelligence will one day produce more mercury than is requisite for all the amalgamation of Peru. We may also hope that in proportion as the inhabitants of the new world shall learn to profit from the natural wealth of the soil, the improvement of chemical knowledge will discover processes of amalgamation by which less mercury is consumed. In diminishing the consumption of this metal, and increasing the produce of the indigenous mines, the American miners will gradually learn to dispense with the mercury of Europe and China.

To complete the view of the mineral substances of New Spain, it remains for us to name coal, salt, and soda. The *coal*, of which I saw in the valley of Bogota * beds at 2500 metres of elevation † above the level of the sea, in general appears to be very rare in the Cordilleras. In the kingdom of New Spain it has only yet been discovered in New Mexico;

* Near Tausa, Canoas, and in the Cerro de Suba, in the road from Santa Fé de Bogota to the salt mine of Zipaquira.

† 8201 feet. *Trans.*

it is however probable that it may be found in the secondary formations which extend to the north and north-west of the Rio Colorado, as well as in the plains of San Luis Potosi, and Texas. There is already a coal mine near the sources of the Rio Sabina. In general coal and rock salt abound to the west of the Sierra Verde near the lake of Timpanogos, in Upper Louisiana, and in those vast northern regions situated between the *stony mountains* of Mackenzie, and Hudson's Bay.*

In the whole inhabited part of New Spain, there is no rock salt like that of Zipaquira in the kingdom of Santa Fe, or of Wieliczka in Poland. The muriate of soda is no where found collected in banks or masses of considerable volume; it is merely disseminated in the argillaceous soil which covers the ridge of the Cordilleras. The table lands of Mexico resemble in this respect those of Thibet and Tartary. We have already observed, in our description of the valley of Tenochtitlan,

* There are salt springs on the banks of the Lake Dauphin and the Lake of Slaves (*des esclaves*). Coal has been found near the river Mackenzie, in the latitude of 66°; and at the foot of the *stony mountains* in the 52° and 56° of latitude. (Mackenzie's Travels in North America, 4to.)

that the Indians who inhabit the caverns of the porphyritic rock called Peñon de los Baños, lixiviate the earth which is impregnated with muriate of soda. It is a received opinion in the country that this salt, like the nitrate of potash, is formed by the agency of the atmospheric air; and in fact it appears that the muriate of soda is merely found in the upper bed of earth to the depth of eight centimetres.* The Indians pay a small sum to the proprietors of the soil for the permission of carrying off the first saliferous bed, knowing that after a few months they will find a crust of clay full of muriate of soda and lime, nitrate of potash and lime, and carbonate of soda. M. del Rio, a distinguished chemist, proposes to make accurate experiments on these phenomena, by lixiviating the new surface before it has again been exposed to the atmospheric air. The most abundant salt mine of Mexico is the lake of the *Peñon Blanco*, in the intendancy of San Luis Potosi, of which the bottom is a bed of clay which contains from 12 to 13 per cent. of muriate of soda. We ought also to observe, that were it not for the amalgamation of silver ores the consumption of salt would be very inconsiderable in Mexico, because the Indians, who

* 3 inches. *Trans.*

constitute a great part of the population, have never abandoned the old custom of seasoning their food with *chile* * or pimento instead of salt.

In taking a general view of the mineral wealth of New Spain, far from being struck with the value of the actual produce, we are astonished that it is not much more considerable. It is easy to foresee that this branch of national industry will continue augmenting as the country shall become better inhabited, as the smaller proprietors shall enjoy more fully their natural rights, and as geological and chemical knowledge shall become more generally diffused. Several obstacles have already been removed since the year 1777, or since the establishment of the supreme council of mines, which has the title of *Real Tribunal general del importante cuerpo de Mineria de Nueva España*, and holds its sittings in the palace of the viceroy at Mexico. Till that period the proprietors of mines were not united into a corporation, or the court

* Chilli or ahi. See vol. ii. p. 505. If we estimate the annual consumption of muriate of soda in Europe at 6 kilogrammes a head, (13.2 lib. avoird. *Trans.*) we dare not estimate the consumption of the copper-coloured race at more than half a kilogramme (about a pound. *Trans.*)

of Madrid at least would not recognize them* as an established body by a constitutional act.

The legislation of the mines was formerly under infinite confusion, because, at the beginning of the conquest, under the reign of Charles the 5th, a mixture of Spanish, Belgic, and German laws was introduced into Mexico; which laws, from the difference of local circumstances, were inapplicable to those distant regions. The erection of the supreme council of mines, of which the chief† bears a name of celebrity in the annals of chemical science, was followed by the establishment of the school of mines, and the compilation of a new code of laws, published under the title of *Ordonanzas de la Mineria de Nueva España.* The council or *Tribunal general* is composed of a director, two deputies from the body of miners, an assessor, two consultors, and a judge, who is head of the *juzgado de alzadas de mineria.* On the *Tribunal general* depend the thirty-seven *councils of provincial mines* or *diputaciones de mineria,* of which the names have been already

* *Representacion que a nombre de la Mineria de esta Nueva España hacen al Rey nuestro Señor los Apoderados de ella, D. Juan Lucas de Lassaga y D. Joaquin Velasquez de Leon,* (Mexico 1774) p. 40.

† *Don Fausto de Elhuyar.*

mentioned. The proprietors of mines (*mineros*) send their representatives to the provincial councils, and the two general deputies who reside at Mexico, are chosen from among the deputies of the districts. The body of miners of New Spain has, besides, *apoderados,* or representative proprietors at Madrid, for treating immediately with the ministry, as to the interest of the colonies, in whatever respects the mines. The students of the *colegio de mineria,* instructed at the expence of the state, are distributed by the *Tribunal* among the head towns of the different *diputaciones.* It cannot be denied that the representative system followed in the new organization of the body of Mexican miners, possesses great advantages. It preserves public spirit in a country where the citizens, scattered over an immense surface, do not sufficiently feel the community of their interests; and it gives the supreme council a facility of collecting considerable sums, whenever any great or useful undertaking is proposed. It is to be desired, however, that the director of the *tribunal* should possess more influence on the progress of the operations in the provinces, and that the proprietors of mines, less jealous of what they call their liberty, were more enlightened as to their true interests.

The *Supreme Council* possesses an income

of more than a million of livres tournois.* The king granted it on its establishment two thirds of the royal right of signiorage, which amounts to a *real de plata*, or the eighth part of a double piastre, per marc of silver delivered in to the mint. This million of revenue is destined for the salaries† of the members of the *tribunal*, the support of the school of mines, and to a fund for assistance or advances (*avios*) to the proprietors of the mines. These advances, as we have already observed, have been given with more liberality than discernment. A miner of Pachuca at one time obtained 170,000 piastres‡; and the share-holders of the *mina de agua* of Temascaltepec, received 214,000 piastres; but this assistance never produced any thing.§ The tribunal during the last years of the war of Spain with France and England, was compelled to make a gratuitous present to the court of Madrid, of two millions and a half of francs, and to lend it fifteen millions besides, six of which have

* 40,816*l.* Sterling.

† These salaries amount to 25,000 piastres. (5250*l.* Sterling. *Trans.*) The director general has only 6000 (1260*l.*); and the seminary or school of mines, in which the Creole, Spaniards, and noble Indians are educated, consumes only 30,000 piastres (6300*l.* Sterling. *Trans.*) per annum.

‡ 35,700*l.* Sterling. *Trans.*

§ See the account rendered to the electors, published under the title of *Estado general que manifiesta a los vocales los caudales del Tribunal de Mineria desde* 1777 *hasta* 1788.

never been repaid. To support these extraordinary expences, they were compelled to have recourse to borrowing; and at present the half of the revenues of the supreme council of mines is employed in paying the interest of that capital. They have increased one half the *signorial impost*, till the period of the liquidation of the debts contracted by the tribunal; and in place of eight *grains*, the miners are obliged to pay twelve* per marc of silver. In this state of things, the tribunal can no longer make advances to the miners, who for want of funds are frequently unable to carry on useful undertakings. Great capitals formerly employed in mining, are now destined to agriculture, and the proprietors of mines would again require those establishments (*bancos de plata, compañias refaccionarias*† *ò de habilitacion y avios*) which advanced to the miners considerable sums of money at a large interest.

All the metallic wealth of the Spanish colonies is in the hands of individuals. The government possesses no other mine than that of

* *Ocho granos de Señoreage, y quatro granos temporalmente impuestos.* At Lima the tribunal receives a real per marc.

† *Real cedula sobre la compañia refaccionaria propuesta por el Genoves Domingo Reborato, del* 12 *Marzo* 1744.—*Don Josef Bustamente, Informe sobre la habilitacion de los Mineros,* 1748.

Huancavelica in Peru, which has been long abandoned; and it is not even proprietor of the great levels, as several sovereigns of Germany are. The individuals receive from the king a grant of a certain number of *measures* on the direction of a vein or bed; and they are only held to pay very moderate duties on the ores extracted from the mines, which have been valued at an average for all Spanish America, at 11½ per cent. of the silver, and 3 per cent. of the gold.*

In New Spain the proprietors of mines pay the government the *half of the fifth* or tenth, the duty of one per cent. (*derecho del uno por ciento*) and the duty of *coinage*, called *derecho de monedage y señoreage*. This last duty, established in 1566 by a law of Philip II. and increased at the end of the 17th century †, now amounts to 3½ reals per marc, of silver, 68 reals being computed in the marc with half a real of expences, and the proprietor of the silver only receiving back 64 reals. Of this 3½ reals, 2½ are accounted *derecho de monedage*, and 1 real *derecho de señoreage*.

* Bourgoing, t. ii. p. 284.

† *Recapilacion de leyes de Castilla, de* 1598, Lib. v. Tit. xxi. n. 9.—*Ley* 8. Tit. xxiii. Lib. iv. de Indias.—*Real cedula* dirigida al Virey Conde de Moctezuma, y dada en Madrid à 26 de Junio, de 1698.

The revenue which the crown derives from 200,000 marcs of silver, equal to 1,700,000 piastres*, is estimated† thus:

	Piastres.
In *Derecho de Diezmo*	160,000
Derecho de uno por Ciento . .	16,000
Derecho de monedage y señoreage	86,750
Total	262,750 ‡

nearly 16½ per cent. In discounting the profit of government under the title of coinage, or the totality of the duty, we find that the duties paid by the proprietors of mines, only amount to 13 per cent. To give a more detailed explanation of the duties levied by the government, we must distinguish, agreeably to information procured by me during my stay at Guanaxuato, the pure silver from that which is mixed with gold; for if the silver contains less than thirty grains of gold per marc of silver, the mint does not pay the gold to the individuals.

* 357,000*l.* sterling. *Trans.*

† Representacion de la mineria de Nueva España, de 1774, p. 53. § 45.

‡ 55,177*l.* sterling. *Trans.*

An ingot of silver unmixed with gold, extracted by the process of amalgamation, weighing 135 marcs, at 11 deniers 22 grains . . . value — piastres. 1171, reals. 6

Expences.

			piastres.	reals.
Duty of one per cent. and tenth . .	127p.	6r.		
Duty of assaying .	4	0		
Duty of *bocado* levied in the treasury .	1	0	147	0
Duty of *bocado* levied in the mint .	0	4		
Duty of signiorage	13	6		
Remain to the proprietor			1024	6

If the silver is procured by smelting, and below 11 deniers 19 grains, we must add the expences of affinage, which amount to 8 maravedis per marc.

An ingot of auriferous silver at the rate of 12 deniers, 19 grains of silver, and 50 grains of gold, weighing 133 marcs, 2 ochavas . . value

	piastres.	reals
In silver	1133	3
In gold	194	0
	1327	3

Expences.

			piastres.	reals.
Duty of one per cent. and tenth .	123p.	6r.		
Duty on gold at 3 per cent. . .	5	6		
Duty of assaying .	6	0	254	3
Duty of *bocado* .	1	4		
Apartado . .	91	7		
Consumo . .	12	2		
Señoreage . .	13	2		
Remain to the proprietor			1073	0

If the ingot is so rich in gold that it contains more than a half of its weight of that metal, the expence of assay rises to 4 reals per marc. It may be seen from these examples that the individual who delivers his silver into the provincial treasuries of Mexico, in exchange for specie, pays in the first case to government 12½, and in the second 19⅛ per cent. This impost excites the proprietors of the mines to the fraudulent extraction of the precious metals. Notwithstanding the experience of so many ages, the court of Madrid has several times attempted* to increase the duty of *signiorage*, without reflecting that this

* *Representacion de la mineria de Nueva España sobre la doble exaccion del Señoreage, de* 1766.

imprudent step would discourage individuals from bringing in their metals to the mint. It is the same with direct imposts on gold and silver, as with the profit which the government attempts to derive from the sale of mercury. The mining operations will increase in proportion as these imposts shall diminish, and as the mercury which is indispensable in the process of amalgamation, shall be furnished at a lower price. It is astonishing that a justly celebrated author, who had the soundest ideas relative to the exchange of metals, should have defended the duties of signiorage.*

From the information given by us in this chapter, it is almost unnecessary to agitate the question, if the produce of the silver mines of Mexico has attained its *maximum*, or if there is any probability that it will still augment in the time to come. We have seen that three mining districts, those of Guanaxuato, Catorce, and Zacatecas, alone furnish more than the half of the whole silver of New Spain, and that nearly one fourth of it is furnished by the mine of Guanaxuato. One mine, which has only been known for forty years, that of Valenciana, has sometimes† alone

* Adam Smith, Book iv. chap. 6.

† For example in 1791.

furnished in one year as much silver as the whole kingdom of Peru. It is but thirty years since the veins of the Real de Catorce began to be worked, and yet by the discovery of these new mines the metallic produce of Mexico was increased nearly one sixth. If we consider the vast extent of ground occupied by the Cordilleras, and the immense number of mineral depositories which have never yet been attempted*, it is very possible that New Spain, under a better administration, and inhabited by an industrious people, may alone one day yield, in gold and silver, the hundred and sixty-three millions of francs at present furnished by the whole of America. In the space of a hundred years, the annual produce of the Mexican mines rose from twenty-five, to one hundred and ten millions of francs. If Peru does not exhibit an equal augmentation of wealth, it is because this unfortunate country has not increased its population, and because, being worse governed than Mexico, industry found more difficulties to overcome. Besides, nature has deposited the precious metals in that country at enormous elevations, in situations where, on account of the very high price of provisions, the working becomes extremely expensive. The abundance

* Especially from Bolaños to the Presidio de Fronteras.

of silver is in general such in the chain of the Andes, that when we reflect on the number of mineral depositories which remain untouched, or which have been very superficially wrought, we are tempted to believe, that the Europeans have yet scarcely begun to enjoy the inexhaustible fund of wealth contained in the New World. When we cast our eyes over the mining district of Guanaxuato, which, on the small space of a few thousand square metres, supplies annually the seventh or eighth part of all the American silver, we shall see that the 550,000 marcs which are annually extracted from the famous *veta madre* are the produce of only two mines, the Valenciana and that of the Marquis de Rayas, and that more than four fifths of this vein have never yet been attempted. It is very probable, however, that in uniting the two mines of Fraustros and Mellado, and clearing them out, a mine would be found of equal wealth with that of Valenciana. The opinion that New Spain produces only perhaps the third part of the precious metals which it could supply under happier political circumstances, has been long entertained by all the intelligent persons who inhabit the principal districts of mines of that country, and is formally announced in a Memoir presented by the deputies of the body of miners to the king in 1774, a production drawn up with great wisdom and knowledge of local circumstances. Europe would be inundated with precious metals, if they were to work at the same time, and with all the means afforded by the improvements in the art of mining, the mineral depositories of Bolaños, Batopilas, Sombrerete, Rosario, Pachuca, Moran, Zultepec, Chihuahua, and so many others which have been long and justly celebrated. I am aware, that in thus expressing myself, I am in direct contradiction with the authors of a great number of works of Political Economy, in which it is affirmed that the mines of America are partly exhausted, and partly too deep to be worked any longer with advantage. It is true no doubt, that the expences of the mine of Valenciana have doubled in the space of ten years, but the profits of the proprietors have still remained the same; and this increase of expence is much more to be attributed to the injudicious direction of the operations than to the depth of the pits. They forget that in Peru, the famous mines of Yauricocha or Pasco, which annually supply more than 200,000 marcs of silver, are yet only from thirty to forty metres in depth.* It appears to me superfluous to refute opinions which are at variance with the numerous facts brought forward by me in this chapter; nor need we be astonished at the

* From 98 to 131 feet. *Trans.*

ignorance we betray in Europe with regard to the state of the mines of the New World, when it is considered how little accuracy is displayed by the most celebrated politicians in their investigations regarding the state of the mines of their own country.

But what is the proportion between the produce of the Mexican mines, and the produce of the other Spanish Colonies? We shall successively examine the wealth of Peru, Chili, the kingdom of Buenos Ayres, and New Grenada. It is known that the other great political divisions, namely, the four *capitanias generales* of Guatimala, the Havannah, Portorico, and Caracas, contain no mines which are wrought. I shall not follow the vague and imperfect data to be found in several very recent works, but shall discuss only what I have been able to procure from official papers communicated to me.

I. There has been given into the mint at Lima,

	marcs of silver.	marcs of gold.
From 1754 to 1772 —	6,102,139	and 129,080
1772 — 1791 —	8,478,367	— 80,846

The value of the gold and silver* amounted in the first of these periods to 68,944,522

* *Unanue, Guia politica del Peru*, 1790, p. 45.

piastres*, and in the second to 85,434,849 piastres†, which on an annual average of gold and silver is

From 1754 to 1772 — 3,830,000 piastres‡.
1772 — 1791 — 4,496,000 §.

The produce of gold has diminished while that of silver has considerably increased. In 1790, the produce of the mines of Peru‖ amounted to 534,000 marcs of silver, and 6,380 marcs of gold. Between 1797 and 1801, there was coined at Lima gold and silver to the amount of 26,032,653 piastres¶. The following table points out the produce of the mines year after year**.

* £14,478,349 Sterling. *Trans.*
† £17,941,308 Sterling. *Trans.*
‡ £804,300 Sterling. *Trans.*
§ £943,026 Sterling. *Trans.*
‖ *Mercurio peruano.* Vol. i. p. 59.
¶ £5,466,000 Sterling. *Trans.*
** *Razon de lo que se ha acuñado en la real casa de moneda de Lima.* (MS.)

Coinage of the Mint at Lima.

Years.	Value of gold in piastres.	Value of silver in piastres.	Value of gold & silver in piastres.
1797	583,724	4,516,206	5,099,930
1798	535,810	4,758,094	5,293,904
1799	496,486	5,512,345	6,008,831
1800	378,596	4,399,409	4,778,005
1801	328,051	4,523,932	4,851,983
Total in 5 years.	2,322,667	23,709,986	26,032,653

In the five preceding years, the produce amounted to 30 millions; so that we may consider six millions of piastres as the mean term for one year, the produce of gold and silver having declined in 1800 and 1801, on account of the maritime war, which impeded the importation of mercury, as well as iron and steel, from Europe. We shall adopt, however, a smaller sum, viz. 3,450 marcs of gold, and 570,000 marcs of silver, the value of which amounts altogether to 5,300,000 piastres.*

The places in Peru most celebrated for abounding with precious metals, or the magnitude of the works, are in following the chain of the Andes from north to south. In the province of *Caxamarca*, the Cerro de Gualgayoc, near Micuipampa, Fuentestiana, and Pilancones; in the

* £1,113,000 Sterling. *Trans.*

province of *Chachapoyas*, S. Thomas, Las Playas de Balzas, and the Pampas del Sacramento, between the Rio Guallaga and l'Ucajale; in the province of *Guamachuco*, the town of Guamachuco, (with the Reales de San Francisco, d'Angasmarca, and de la Mina Hediconda), Sogon, Sanagoran, San Jose, and Santiago de Chucu; in the province of *Pataz*, the town of Partaz, Vuldivuyo, Tayabamba, Soledad, and Chilia; in the province of *Conchucos*, the town of Conchucos, Siguas, Tambillo, Pomapamba, Chacas, Guari, Chavin, Guanta, and Ruriquinchay; in the province of *Huamalies*, Guallanca; in the province of *Caxatambo*, Chanca, and the town of Caxatambo; in the province of *Tarma*, the Cerro de Yauricocha, (two leagues to the north of Pasco) Chaupimarca, Arenillapata, Santa Cathalina, Caya grande, Yanacanche, Santa Rosa, and the Cerro de Colquisirca; in the province of *Huarochiri**, Conchapata; in the province of *Huancavelica*, San Juan de Lucanas; and lastly, in the confines of the desert of Atacama, Huantajaya.

I have followed in this long enumeration the old division of Peru into provinces; but since

* The mountains of Huarochiri and Canta contain excellent coal; but on account of the high price of carriage, they cannot be used at Lima. Cobalt and antimony have also been discovered at Huarochiri.

the frontier of the kingdom of Buenos-Ayres has been made to pass to the west of the lake of Chucuito, between the lake and the city of Cuzco, and since on the one hand the kingdom of Quito and the provinces of Jaen de Bracamoros and Maynas, and on the other the governments of Paz, Oruro, Plata, and Potosi, have been separated from Peru, this last kingdom is divided into seven intendancies, *Truxillo*, *Tarma*, *Huancevalica*, *Lima*, *Guamanga*, *Arequissa*, and *Cuzco*, of which each comprehends several departments or partidos.* We can only arrive at false results when, as has been done in works of the greatest estimation, we compare the produce of the mines of old Peru, with that of the present Peru, which since the year 1778, includes within its limits neither the Cerro del Potosi nor the mines of Oruro and la Paz. The Peruvian gold partly comes from the provinces of Pataz † and Huailas, where it

* The old provinces of Pataz, Guamachuco, and Chachapoyas are now considered as *partidos* of the intendancy of Truxillo; and those of Caxatambo, Huailas, Conchucos, and Huamalies, belong to the intendancy of Tarma. The capitals of the seven intendancies are: Lima with 52,600 inhabitants; Guamanga with 26,000; Arequipa with 24,000; Truxillo with 5800; Huancavelica with 5200; Tarma with 5600; and Cuzco with 32,000. *(Guia politica, ecclesiastica y militar del Vireynato del Peru, para el ano* 1793, *por Don Jose Hipolito Unanue).*

† Among the five mining districts of the *partido* of

is extracted rom veins of quartz which traverse primitive rocks, and partly from stream works established on the banks of the Alto Maranon, in the *partido* of Chachapoyas.

As in Mexico, almost the whole produce is derived from the mines of Guanaxuato, Catorce, Zacatecas, Real del Monte, and New Biscay, so in Peru nearly the whole silver is extracted from the great mines of Yauricocha or Lauricocha, (commonly called mines of *Pasco* and the *Cerro de Bombon**) and those of Gualgayoc or *Chota*, and *Huantajaya* (pronounced Guanta-ha-ya).

The mines of *Pasco*, which are the worst wrought in all Spanish America, were discovered by Huari Capca, an Indian, in 1630; they annually furnish nearly two millions of piastres. To form a just idea of the enormous mass of silver which nature has deposited in the bowels of these calcareous mountains, at an elevation of more than four thousand metres (13 thousand feet) above the level of the ocean

Pataz which we named above, only that of Chilia furnishes silver.

* The high table land of the Cordilleras, on which we find the small lake *de los Reyes*, to the south of the Cerro de Yauricocha, is called the *Pamba de Bombon*. We must not seek the position of Pasco on the map of La Cruz, but on the map of the Rio Huallaga, drawn up by Father Sobreviela, and published in 1791 by the *Sociedad de los Amantes del pais de Lima*.

we must bear in mind that the bed of argentiferous oxide of iron of Yauricocha has been wrought without interruption since the beginning of the seventeeth century, and that within the last twenty years more than five millions of marcs of silver have been extracted from it, while the greatest part of the pits are not more than thirty metres in depth, and none of them one hundred and twenty metres. The water, which is very abundant in these mines, is drawn off, not by hydraulic wheels or horse *baritels* as in Mexico, but by pumps moved by men, so that, notwithstanding the small depth of these miserable excavations, which go by the names of pits and galleries, the drawing off the water from the mines is excessively expensive. In the mine of La Luna, the expence amounted, a few years ago, to more than a thousand piastres per week. The mines of Yauricocha would supply the same quantity of silver as Guanaxuato, if they would but construct hydraulic machines or steam engines, for which they might make use of the turf of the lake of Giluacocha. The metalliferous bed (*manto de plata*) of Yauricocha appears at the surface for a length of 4800 metres * and a breadth of 2200 †. The following table, extracted from the books of the provincial treasury of Pasco, specifies the number and weight of the ingots of silver smelted at Pasco, between the years 1792 and 1801.

* 15,747 feet. *Trans.*
† 7217 feet. *Trans.*

Mining operations of Yauricocha.

Periods.	Ingots.	Marcs of silver.
1792	1052	183,598
1793	1325	234,943
1794	1621	291,254
1795	1550	279,622
1796	1561	227,514
1797	1340	242,949
1798	1478	271,862
1799	1237	228,356
1800	1198	281,481
1801	914	237,435
Total of 10 years	13,276	2,479,014

It appears from this table that the produce of Pasco has almost never been below two hundred thousand marcs *, and that it amounted in 1794 and 1801 nearly to the sum of three hundred thousand marks of silver. †

The mines of Gualgayoc and Micuipampa, commonly called *Chota*, which I had occasion to examine very minutely in 1802, were only discovered in 1771 by Don Rodriguez de

* 131,263 lb. troy. *Trans.*
† 196,894 lb. troy. *Trans.*

Ocaño, a European Spaniard. In the time of the Incas, the Peruvians wrought veins of silver in the Cerro de la Lin, near Cutervo, at Chupiquiyacu, to the west of the small town of Micuipampa, where the thermometer descends almost every night to the freezing point, and which is seven hundred metres * higher than the town of Quito. Immense wealth has been found even at the surface, both in the mountain of Gualgayoc, which rises like a fortified castle in the midst of the plain, and at Fuentestiana, at Cormolache, and at la Pampa de Navar. In this last plain, for an extent of more than half a square league, wherever the turf has been removed, sulphuret of silver has been extracted, together with filaments of native silver adhering to the roots of gramineous plants. Frequently the silver is found in masses, (*clavos y remolinos*) as if smelted portions of this metal had been poured upon a very soft clay. The produce of the mines of Gualgayoc or Chota is very unequal in proportion to the inconstancy of the veins which, at Fuentestiana and Cormolache, traverse alpine lime-stone; at Gualgayoc and the Purgatorio, as well as at the Cerro de San Jose, horn-stone, called *panizo*. This horn-stone forms a subordinate bed in the calcareous rock, as has been clearly recognized on digging the pits of Choropampa, to the east

* 2296 feet. *Trans.*

of the Purgatorio, near the Ravin de Chiguera. All the mines comprehended under the name of mines, of Gualgayoc, on the Partido de Chota, have furnished to the provincial treasury of Truxillo, between the month of April 1774, and the month of October 1802, the sum of 1,912,327 marcs of silver *, or, at an average, 67,193 marcs annually. †

* 1,189,456 lb. troy. *Trans.*

† 44,095 lb. troy. *Trans.*

Produce of the silver mines of Hualgayoc, Guamachuco, and Conchuco.

Periods.	Number of ingots of silver.	Weight.		Duty of fifth.
		Marcs.	Ounces.	
				Piastres.
1774	182	34,403	4	33,852
5	300	57,894	5	56,941
6	432	84,326	1	82,985
7	302	60,015	3	59,051
8	327	65,062	3	64,034
9	324	64,203	7	63,214
1780	306	60,981	0	60,021
1	308	61,435	4	60,387
2	429	73,698	6	72,462
3	329	58,713	6	57,808
4	335	61,564	0	60,440
5	397	73,604	2	72,373
6	398	73,305	6	72,024
7	450	83,633	0	82,209
8	404	73,835	5	74,371
9	469	87,484	0	83,469
1790	645	119,183	5	117,241
1	575	105,383	2	103,618
2	731	134,084	4	131,939
3	406	72,904	6	71,713
4	480	86,876	1	85,505
5	434	79,309	4	78,047
6	428	77,997	5	76,755
7	378	67,789	3	66,721
8	501	90,015	4	88,600
9	607	108,591	6	106,889
1800	392	70,595	6	69,471
1	255	45,378	3	44,626
2	267	48,198	6	47,413
Total in 29 years.	11,791	2,180,470	3	2,144,179

This table, which was framed at my request in the offices of the intendancy, exhibits the quantity of silver given into the *Cayana de Truxillo*, as well as the duties of tenth and one and a half per cent. paid to the king. Of 11,791 ingots, nearly an eighth part, or 1450, came from the *partidos* of Guamachuco, and Conchuco. I could not procure the produce of the Cerro de Gualgayoc since the discovery of the mines in 1771 to 1774. These years were undoubtedly the most abundant of all; but as the money was sent at that period to Lima, the archives of Truxillo could furnish no information relative to them. It is very reasonably believed, that under a more enlightened government, the Cerro de Gualgayoc would become another Potosi. In fact, its ores are richer than those of Potosi, and they are more constant in their produce than those of Huantajaya, and easier to work than those of Yauricocha.

The mines of Huantajaya, surrounded with beds of rock salt, are particularly celebrated on account of the great masses of native silver which they contain in a decomposed gangue; and they furnish annually between 70 and 80 thousand marcs of silver.* The conchoidal muriate of silver, sulphuret of silver,

* From 45,942 to 52,505 lb. troy. *Trans.*

small grained galena, quartz, carbonate of lime, accompany the native silver. These mines are situated in the *partido* of Arica, near the small port of Yquique*, in a desert entirely destitute of water. A project has long been entertained of carrying fresh water to it, for the use of the men and cattle; and water from the sea for the amalgamation works. In 1758 and 1789, two *pepitas* of massive silver were discovered in the mines of Coronel and Loysa, the one weighing eight and the other two quintals.

The little elevation of the mine of Huantajaya, on the shore of the Pacific Ocean, forms a singular contrast with the summit of the Cerro de Gualgayoc, where, at a height of 4080 metres†, the masses of vitreous silver are found; and it proves the vagueness of the systematical ideas advanced by celebrated geologists, relative to the distribution of the metals according to the variety of climates and latitudes. Ulloa, after travelling over a great part of the Andes, affirms that silver is peculiar to the high table lands of the Cordilleras, called *Punas* or *Paramos*; and that gold on the other hand abounds in the lowest, and consequently warmest re-

* Along the coast of Taparaca.

† 13,385 feet. *Trans.*

gions *; but this learned traveller appears to have forgot, that in Peru the richest provinces in gold are the *partidos* of Pataz and Huailas, which are on the ridge of the Cordilleras. The Incas drew immense quantities of gold from the plains of Curimayo to the north-east of the town of Caxamarca, at more than 3,400 metres † of elevation. It has also been extracted from the right bank of the Rio de Micuipampa, between the Cerro de San Jose, and the plain called by the natives *Choropampa*, or *plain of shells*, on account of an enormous quantity of oysters, cardia, and other petrifications of marine shells, contained in the formation of alpine limestone of Gualgayoc. Considerable masses of gold have been found there, disseminated in branches and filaments, in veins of red and vitreous silver, at more than 4000 metres of elevation above the level of the ocean.‡ As to the alluvial ground in which the gold stream-works of Choco are established, and those of la Soñora and Brazil, are we to be surprised to find them rather at the bottom than on the summits of mountains? If tin § appears an exception to this law of nature,

* *Ulloa, Noticias Americanas.* 1772, p. 223 and 236.

† 11,154 feet. *Trans.*

‡ 13,123 feet. *Trans.*

§ For instance, the tin of the stream-works *(Wasch-zinn)*, on the summit of the Fichtelgebirge.

it is undoubtedly because the granitic beds, in which it was originally contained, have been decomposed in their place.

The process of amalgamation of silver minerals followed in Peru, since 1571, is the same as that which is used in Mexico. In the two countries the *schlich* is manufactured according to the rules prescribed by Medina, Barba, Corso de Leca and Corrosegarra; but, generally speaking, amalgamation is practised with more care and intelligence by the Mexican miners at Guanaxuato and Zacatecas, than by the miners of Peru. In New Spain the expence of amalgamation is generally estimated at 87 piastres 4 reals for one hundred quintals of minerals, containing four ounces of silver per quintal, of which sum, 25 piastres go for waste of mercury. As three hundred quintals produce fifty marcs of silver, which, according to the common price of silver * at the mines, are worth 362 piastres, it follows that the expence of amalgamation amounts nearly to 24 per cent. of the value of the silver. But in Peru, where the mercury of

* At 7 piastres, 2 reals. *Garces*, p. 144. In the beginning of the seventeenth century, the expences of amalgamation at Potosi, for a *caxon* of ore weighing 5 quintals, and containing 20 marcs of silver, were only estimated at 30 piastres, or 20 per cent. although the pound of mercury cost a piastre. *Barba*, p. 118.

Huancavelica is generally sold for 60 or 70 piastres the quintal *, the expences amount, in several districts of mines, to 30 or 38 per cent. At the *Cerro de Gualgayoc* for example, where the price of labour is from three to four reals (from 40 to 50 sous) per day, a load of *schlich*, containing from two to three marcs of silver, costs seven piastres in the process of amalgamation, viz.

	Reals of silver.
In roasting { wood	8
In roasting { labour	2
Muriate of Soda	6
Lime	4
Labour in treading the schlich	12
Consumption of mercury	24
Total	56

During my stay in the Cordillera of the Andes, there were only two districts of mines where the method of M. de Born, of *amalgamation in casks*, was followed with any degree of success, namely, the Real de Requay, in the province of Huailas, and Tallenga, in the province of Caxatambo. † To judge of the considerable loss of silver annually experienced in

* *Campomanes, de la educacion popular*, T. ii. p. 132.

† The mines near Requay, where a German amalgamation work has been constructed, is called Ticapamba, and belongs to Don Juan Ignacio Gamio. The work of Tallenga was established by Don Juan Baptista Arieta.

Peru from the ignorance of the *amalgamators*, it is enough to mention the simple fact that it daily happens that an *azoguero* extracts 15 marcs per *caxon*, from the same mineral, out of which, hitherto, there has never been extracted more than ten or twelve marcs. In the years which immediately succeeded the discovery of the mines of Yauricocha, they only wrought the *pacos* or oxides of iron, mixed with native silver, and muriate of silver. The prismatic black silver, and the argentiferous grey copper, were thrown among the rubbish. In the same manner, on building the small town of Micuipampa, walls were constructed of very rich pieces of *gangue*, and those minerals only which were of a yellowish brown, or of an earthy appearance, like the *pacos*, were considered as containing silver. These facts will not appear so surprising, when we consider that not more than forty years ago, in one of the most civilized countries of Europe, calamine was employed in the making of roads, without its being perceived that this substance, which was soiled with clay, contained zinc.

II. The *Precidentia*, or *Capitania general* of Chili, produces annually, in gold and silver, one million seven hundred thousand piastres. *

* £ 357,000 Sterling. *Trans.*

The most considerable mines of gold, are Petorca, ten leagues to the South of Chuapa; Yapel or Villa de Cuscus, Llaoin, Tiltil and Ligua, near Quillota. Mines are also wrought in the *partidos* of Copiapo, Coquimbo and Guasco. The silver mining operations of Chili are in general by no means productive. The Cerro de Uspallata, at eight leagues distance to the north-west of Mendoza, contains, however, *pacos* so rich that they yield from two to three thousand marcs per *chest* (*caxon*) of 5000 pounds, or 40 or 60 marcs of silver per quintal. The produce of the mines of Chili, has considerably increased of late years. In 1790 there was coined at Santiago 721,000 piastres in gold, and 146,000 in silver.

III. The great mass of precious metals, supplied by the viceroyalty of Buenos Ayres, is entirely derived from the most western part, the *provincias de la Sierra*, which in 1778 were separated from Peru. We may estimate the annual produce, which is almost wholly silver, at four millions two hundred thousand piastres. * The districts which supply the most are Potosi, Chaganta, Porco †, Oruro,

* 882,000*l.* Sterling. *Trans.*

† See *Alonzo Barba*, *Arte de los Metales* (ed. 1729) p. 48, respecting the silver mines of Porco, wrought by the Incas.

Chucuito, la Paz, Caylloma, and Carangas. In the intendancy of Puno, the mountains of Ananca, near Caravaya and Azangara, to the north-east of the lake of Titicaca, were celebrated in the first years of the conquest on account of the wealth of their mines of gold. * Thoughts were entertained in 1803 of resuming the old operations of Morocollo, in the Pampa Fungoso de la Rinconada, and on the banks of the lake of Communi. They sought also to continue the gallery of Vera Cruz, in the famous silver mine of Salcedo, situated in the mountains of Ycacota and Cancharani.

The mountain of Potosi † has alone furnished, including only the silver which has paid the royal duties, since its discovery in 1545 to our days, a mass of silver equal to 5750 millions

* *Proclamacion del Intendente de Puno, D. Jose Gongalez.* Platina is also said to have been discovered near Morocollo, but the fact has never yet been confirmed by persons deserving of credit.

† Potosi, properly Potocchi, Potossi or Potocsi. The old name of Huancavelica is Huanca-Villca. *Garcillasso, Com-Reales*, lib. viii. c. 25. *Pedro de Cieça de Leon, Chronica del Peru*, c. 109. The porphyrry bed which crowns the mountain of Potosi, the *Hatun-Potocsi*, gives it the form of a sugar-loaf or basaltic hill (see p.). This mountain is 1624 varas, or 697 toises above the neighbouring plain, *Acosta*, lib. iv. c. 6. *Hernandez*, p. i. lib. xi. c. 2. *Helms*, p. 65—122.

of livres tournois. * Ulloa has communicated some historical information respecting this mining operation, which has had the most powerful effect on the commerce and price of commodities of Europe; but he could only collect very incomplete materials, founding his calculations on the consumption of mercury in the amalgamation works. I am enabled to publish from official papers, year after year, between 1556 and 1789, the value of the duties (*derechos reales*) paid into the provincial treasury of Potosi, on the silver given into the mint. As the proportion which has existed at different periods between these duties and the value of the silver extracted from the mines, is known, we may deduce from the three following tables the annual produce in piastres.

* £234,693,840 Sterling *Trans.*

ROYAL DUTIES (Derechos Reales.)

Paid on the silver extracted from the Cerro de Potosi.

TABLE I.

First period, from 1st January 1556, to 31st December 1578, during which the fifth alone was paid.

Years.	Fifth. Piastres.	Reals	Years.	Fifth. Piastres.	Reals	Years.	Fifth. Piastres.	Reals
1556	450,734	1	1564	396,158	4	1572	216,117	3
1557	468,534	5	1565	519,944	1	1573	234,972	1
1558	387,032	0	1566	486,014	3	1574	313,778	5
1559	377,031	2	1567	417,107	1	1575	413,487	4
1560	382,428	3	1568	398,381	3	1576	544,614	6
1561	405,655	7	1569	379,906	7	1577	716,087	6
1562	426,782	1	1570	325,467	1	1578	825,505	2
1563	449,965	3	1571	266,200	4			

Total of the 23 years 9,801,906 piastres.

TABLE II.

Second period from the 1st January 1579, to the 19th July 1736, during which at first one and a half per cent. *cobos* was paid, and afterwards the fifth of the remaining 98 piastres 4 reals.

Years.	One and a half per cent. and fifth. Piastres.	Reals	Years.	One and a half per cent. and fifth. Piastres.	Reals	Years.	One and a half per cent. and fifth. Piastres.	Reals
1579	1,091,025	3	1606	1,434,981	5	1633	1,003,756	0
1580	1,189,323	1	1607	1,414,660	1	1634	984,414	6
1581	1,276,872	6	1608	1,200,488	5	1635	946,781	0
1582	1,362,855	7	1609	1,132,680	4	1636	1,424,758	6
1583	1,221,428	3	1610	1,139,725	4	1637	1,197,572	4
1584	1,215,558	1	1611	6,299,052	2	1638	1,174,393	0
1585	1,526,455	1	1612	1,329,701	7	1639	1,128,738	2
1586	1,456,958	0	1613	1,200,947	6	1640	978,483	2
1587	1,226,328	0	1614	1,269,692	7	1641	940,367	1
1588	1,441,657	0	1615	1,354,412	3	1642	905,797	6
1589	1,578,823	7	1616	1,257,599	0	1643	924,659	0
1590	1,422,576	1	1617	1,071,932	4	1644	871,174	3
1591	1,562,522	2	1618	1,061,264	2	1645	908,414	4
1592	1,578,449	6	1619	1,108,744	6	1646	840,982	0
1593	1,589,662	1	1620	1,069,599	3	1647	891,287	0
1594	1,403,555	7	1621	1,099,244	1	1648	1,123,932	2
1595	1,557,221	3	1622	1,093,201	4	1649	1,067,376	1
1596	1,468,182	5	1623	1,083,641	7	1650	917,845	7
1597	1,355,954	6	1624	1,086,999	0	1651	757,418	6
1598	1,310,911	7	1625	1,024,794	3	1652	796,244	2
1599	1,339,685	2	1626	1,033,868	7	1653	759,904	5
1500	1,299,028	5	1627	1,068,612	3	1654	835,109	4
1601	1,477,489	7	1628	1,172,352	3	1655	754,784	1
1602	1,519,152	7	1629	972,807	0	1656	804,071	0
1603	1,478,697	6	1630	962,250	4	1657	933,441	4
1604	1,326,231	6	1631	1,067,001	6	1658	877,862	1
1605	1,532,646	6	1632	964,370	6	1659	799,609	1

SEQUEL OF TABLE II.

	One and a half per cent. and fifth.			One and a half per cent. and fifth.			One and a half per cent. and fifth.	
Years.	Piastres.	Reals	Years.	Piastres.	Reals	Years.	Piastres.	Reals
1660	652,728	4	1686	586,835	7	1712	204,931	6
1661	623,250	7	1687	645,318	1	1713	279,913	1
1662	638,167	3	1688	646,077	3	1714	265,087	1
1663	579,126	7	1689	647,189	0	1715	228,224	0½
1664	605,450	3	1690	673,097	1	1716	239,287	0½
1665	655,557	0	1691	593,976	1	1717	356,804	1
1666	675,729	4	1692	424,761	7	1718	322,251	1
1667	708,879	2	1693	570,870	2	1719	283,593	3
1668	691,169	0	1694	546,928	3	1720	231,256	7
1669	624,126	4	1695	557,145	1	1721	229,002	0
1670	554,614	0	1696	500,965	3	1722	228,208	5
1671	667,992	3	1697	471,686	4	1723	214,740	3
1672	624,037	6	1698	434,772	1	1724	245,793	4
1673	676,811	0	1699	434,287	0	1725	223,083	3
1674	673,694	7	1700	405,492	5	1726	274,416	1
1675	567,827	5	1701	338,572	4	1727	286,328	3
1676	514,530	4	1702	372,447	1	1728	220,698	1
1677	550,099	3	1703	360,114	6	1729	360,414	7½
1678	653,067	1	1704	333,702	0	1730	303,361	6½
1679	622,979	5	1705	319,264	7	1731	293,497	3
1680	629,270	0	1706	354,600	1	1732	308,137	3½
1681	685,791	0	1707	364,415	0	1733	304,768	3½
1682	659,341	0	1708	374,183	6	1734	273,084	5½
1683	731,599	6	1709	334,080	4	1735	271,621	6
1684	719,082	0	1710	309,008	1	1736	149,567	0½
1685	655,256	0	1711	246,147	1			

Total of the 158 years, 129,417,273 piastres.

TABLE III.

Third period between the 20th July 1736, and the 31st December 1789, during which one and a half per cent. and the half of the fifth were paid, or 11 piastres 3 reals per 100 piastres.

	One and a half per cent. and the half fifth.			One and a half per cent. and the half fifth.			One and a half per cent. and the half fifth.	
Years.	Piastres.	Reals	Years.	Piastres.	Reals	Years.	Piastres.	Reals
1736	85,410	2	1754	244,148	2	1772	298,983	1¼
1737	183,704	3	1755	221,872	4	1773	306,925	3
1738	159,252	7	1756	249,513	7	1774	317,703	4
1739	183,295	6½	1757	244,760	6	1775	332,329	4½
1740	170,229	4	1758	262,835	4½	1776	346,319	5
1741	179,573	6	1759	263,701	6	1777	390,676	5½
1742	161,976	0	1760	272,059	1	1778	351,994	6½
1743	166,131	1½	1761	261,580	7	1779	348,035	4
1744	155,926	3	1762	257,201	7½	1780	400,062	1½
1745	163,140	0½	1763	279,646	6½	1781	323,109	2
1746	178,080	6	1764	263,092	1½	1782	350,199	2
1747	184,156	5½	1765	281,985	5	1783	400,238	3½
1748	197,022	7½	1766	282,405	0½	1784	371,362	2
1749	215,283	3	1767	303,650	6	1785	351,777	7½
1750	233,677	5	1768	306,674	7½	1786	332,507	1
1751	238,502	3	1769	291,075	3	1787	390,836	7½
1752	227,133	5	1770	292,203	3	1788	380,600	1¾
1753	244,888	1½	1771	307,765	3½	1789	335,468	6

Total of the 54 years 14,542,684 piastres.

The result of these three tables, as we have already observed *, on comparing the present produce of the mines of Guanaxuato in Mexico, with the produce of the mountain of Potosi, is, that during the space of 233 years, from 1556 to 1789, there has been extracted from the mines of Potosi, in silver declared at the Royal Treasury, the amount of upwards of 788 millions of piastres. If these piastres were all Mexican piastres, at 8 reals of *Plata Mexicana*†, the produce of these 233 years would amount to 92,736,294 marcs.‡ But we shall shortly see that the mass of silver on which duty has been paid is still greater.

The books of accounts preserved in the archives of the provincial treasury of Potosi, do not go further back than the year 1556. It remains therefore to examine what was the quantity of silver supplied by the mines of Potosi before that period. This examination is the more important, as it is very reasonably believed that the first years which fol-

* See p. 171.

† We must take care not to confound three species of reals *de plata*; viz. the *real de plata antigua* of 64 maravedis de vellon; the *real de plata nueva* or *provincial* of 68 maravedis; and the *real de plata Mexicana* of 85 maravedis. We constantly make use of the latter in this work (*Damoreau Traité des Banques*, 1727, p. 115. *Encyclop. Méthodique*, Commerce, t. iii. p. 211.)

‡ 60,851,231 lb. troy.

lowed the discovery of the veins, were the most productive in riches.

Ulloa * quotes a book published in 1634, by Don Sebastiani Sandoval y Guzman, under the title of *Pretensiones del Potosi*, in which the author specifies the fifth paid between 1545 and 1633. I endeavoured in vain to procure this work during my stay in Peru; and not knowing the partial data which it contains, I can only examine the results stated by the Spanish astronomer. This examination becomes the more necessary, as the assertions of Ulloa have been repeated by Raynal †, and by all the other writers who treat of the quantity of gold and silver imported from America into Europe, during the first years of the conquest. According to Sandoval, the fifth, paid into the royal treasury of Potosi, was at an average from 1545 to 1564, four millions of piastres of $13\frac{1}{2}$ *reales de plata;* from 1564 to 1585, 1,166,000 piastres; from 1585 to 1624, 1,333,000 piastres; and from 1624 to 1633, 666,000 piastres. These numbers, between 1564 and 1633, do not coincide very well with the annual sums stated in the foregoing tables; the differences are sometimes the one way, and sometimes the other; but it is in a particular manner respect-

* *Noticias Americanas, Entretenimiento* xiv. § xvii. p. 256.

† *Hist. Philosophique*, (édit. de Genève, 1780) t. ii. p. 229.

ing the fifth of four millions, for the period which precedes the year 1564, that we may most reasonably entertain well founded doubts.

Were this sum accurate, the produce of silver extracted from the mine of Potosi, and registered in the royal treasury, would have amounted in nineteen years, between 1545 and 1564, to 641,250,000 Mexican piastres *, reducing the piastres of 13½ reals to piastres of 8 reals. On the other hand, it is proved, by official papers in my possession, that the produce in eight years, from 1556 to 1564, amounted to 28,250,000 of the same Mexican piastres †. The result of these data of Sandoval would consequently be, that during the first eleven years between 1545 and 1556, the Cerro del Potosi must have yielded in silver, of which the fifth was paid, 613 millions of piastres ‡, or at an yearly average, 55,726,000 piastres §, equal to 6,556,000 marcs of silver ||. This is a very extraordinary result, yet it contains nothing which may be considered as impossible. We may be surprised to see that a single mountain of Peru, has yielded from two to three times more silver than all the collected

* 134,662,500*l.* Sterling. *Trans.*
† 5,932,500*l.* Sterling. *Trans.*
‡ 128,730,000*l.* Sterling. *Trans.*
§ 11,701,326*l.* Sterling. *Trans.*
|| 4,302,810 lb. Troy. *Trans.*

mines of Mexico; but our ideas of wealth are merely relative. It is possible that we may one day discover mountains in the centre of Africa, which, with respect to their abundance in the precious metals, may bear the same proportion to the Cordilleras, which the Cordilleras bear to the mountains of Europe. The mine of Valenciana supplies annually more silver than all Saxony, and the single vein of Guanaxuato, wrought throughout its whole length, would be able to produce more than two millions of marcs of silver annually. * We have already observed that there has been extracted from the vein of the veta grande of Sombrerete, for an extent of 30 metres, more than 700,000 marcs, in the space of five months. When we reflect on the masses of native, red, and sulphuretted silver, discovered in our days at Huantajaya in Peru, as well as at Batopilas and the Real del Monte in Mexico, we may conceive what a prodigious quantity of silver may be supplied, by a mineral depository in the Cordilleras of the Andes, when the abundance of produce is united to intrinsic wealth. It is not then the enormous quantity of silver which is supposed to have been extracted during the first eleven years, which induces me to call in question the testimony of Sandoval;

* 1,312,633 lb. Troy. *Trans.*

but it is the contradiction which exists between this testimony, and other well authenticated facts.

Ulloa, Robertson, Raynal, and the writers of the *Encyclopédie Méthodique*, have not attended to a passage of the Chronicle of Peru, written by Pedro Cieça de Leon. The author who writes with that admirable *naïveté*, which characterizes all the travellers of the fifteenth and sixteenth century, proposes to give his countrymen an idea of the prodigious wealth of the mountain of Potosi. He was the better enabled to do this from being on the spot in 1549, four years after the first discovery of these celebrated mines. He relates what he saw himself, while Sandoval speaks of a period more than 90 years before. If we are to suspect the numbers of Cieça of error, we ought rather to believe that the error lies on the side of excess; for a traveller who aims at effect, and who hopes to astonish his readers, is naturally inclined to exaggeration. Let us now examine what the historian of Peru relates.* "The wealth of the *Cerro de Potosi*," says he, "is so much beyond what was ever "seen in former times, that to shew the great-"ness of these mines, I shall describe them "as I saw them with my own eyes, when I

* Cieça Chronica del Peru, cap. cviii. (ed^n. 1554) p. 261.

"passed through Potosi in 1549, at the period "when the Licentiate Polo was Corregidor "of the town. The chests (royal) with three "keys are in the house of this Corregidor. "His Majesty received every week from twenty-"five to thirty, and sometimes even forty thou-"sand piastres. They complained at that time "that the mines went on poorly, when the "fifth only amounted to 120,000 *castellanos* "monthly. And yet all this money belonged "to the Christians alone; for the Indians stole "a great deal which was not registered; so "that no where in the world was there ever "so rich a mountain, and no where did any "Prince ever draw so great a revenue from a "single town; for between 1548 and 1551, "the fifth brought into the King more than "three millions of ducats."

To understand this passage, which contains three distinct valuations, we must recollect that the *pesos* or piastres of that time, and till 1580 at least*, were an imaginary money of 480 maravedis or nearly 13½ *Reales de plata Mexicana*. A marc of silver contained $5\frac{1}{17}$ of these piastres. Five piastres made a ducat of 11¼ reals. According to these data then, reckoning the fifth with Cieça, at 30,000 piastres per week, and

* *Garcilasso, Coment. Reales*, t. i. in the second preface which bears the title of *Advertencias acerca la lengua general del Peru*; and t. ii. p. 51.

120,000 *castellanos* per month, the total produce of the mines of Potosi was (in registered silver), in the year 1549, either 1,549,000, or 1,440,000 marcs. The same produce amounted, according to Cieça, at an average from 1548 to 1551, only to 7,031,000 Mexican piastres of eight reals of plata, equal to 827,000 marcs of silver. This sum forms a singular contrast with the account of Sandoval and Ulloa: but it agrees very well with the fifth of the years when our first table commences. It might remain doubtful whether Cieça speaks really of the totality of the royal duties, levied between 1548 and 1551, or whether he affirms that during that period, the fifth amounted to three millions of ducats per annum. In this last case, the annual produce would have amounted to 21,093,000 Mexican piastres, or 2,481,000 marcs of silver; a very considerable sum no doubt, but still very much below the calculation of Ulloa and Raynal. I am inclined to believe, that the historian of Peru estimates only at three millions of ducats, the sum total of the fifths of the four years; 1st, Because this valuation is more agreeable to the value of the fifth of 1556; 2d, Because Cieça, to give the highest idea of the wealth of the mines, says, that the fifth *sometimes* amounted to 40,000 piastres, which would give for the *maximum* of annual produce at that time, a sum not

above 2,481,000, but hardly equal to 2,065,000 marcs; 3d, Because Garcilasso * relates that about the same period, from ten to twelve millions of piastres in gold and silver of Peru, every year entered the Rio Guadalquivir.

Considering these data of Sandoval as accurate, and combining them both with those of Cieça, and the numbers contained in the official papers published by me, we shall find the following unsatisfactory results for the average annual produce of the mines of Potosi:

From 1545	to 1548	23,284,000 marcs of silver.
1548	1551	827,000
1551	1556	621,000
1556	1564	415,000

The following is the foundation for this calculation. Sandoval and Ulloa estimated the produce of the Cerro de Potosi, between 1545 and 1564, at an average 33,750,000 piastres per annum, or 3,970,000 marcs of silver. Now, we know from the chronicle of Cieça, what was the amount of the produce between 1548 and 1551; the registers of Potosi contain the produce from 1556 to 1564; and supposing for the intermediate period from 1551 to 1556, a decrease in arithmetical progression, it is easy, to find from the 641,250,000 Mexican piastres,

* *Garcilasso*, ii. p. 52.

or 75,440,000 marcs of silver, stated by Sandoval as the total proportion of the first 19 years, the proportional amount for the small interval from 1545 to 1548.

If we admit, what appears equally improbable, that Cieça indicated the fifth of each of the four years contained in the period from 1548 to 1551, we find, by an analogous operation, that the annual produce of the mines of Potosi amounted,

From 1545 to 1548 to 19,146,000 marcs of silver.

1548	1551	2,481,000
1551	1556	1,448,000
1556	1564	415,000

Thus whatever interpretation we give to the passage of the chronicle of Cieça, we shall find it is evident in both hypotheses, that the produce of the first three years differs so much from the following years, that we ought very much to suspect the account of Sandoval. We ought the more to suspect it, as on examining the table of fifths between 1556 and 1789, we discover in this long series of numbers, a law according to which they uniformly increase or decrease. Cieça visited the mines of Potosi, at the period of their greatest splendour; and he expressly says, that he described the mountain as he found it in 1549, "because that "wealth, like every thing human, must vary "in the course of time, either increasing or

"diminishing." If the produce of 1549, was really eight or ten times less than that of 1546, how should the traveller have passed over this enormous diminution of wealth in silence.

We may conclude, from the whole of these discussions, that the total produce of silver registered during the eleven years which are deficient in the preceding tables, far from amounting to 72 millions of marcs, as we might be led to suppose from Ulloa, and the celebrated author of the *Recherches Philosophiques*, has not exceeded the sum of 15 millions of marcs. Nor can we give great faith to Solorzano *, who vaguely asserts that Potosi yielded between 1545 and 1628, that is in 83 years, the sum of 850 millions of pounds of silver, which is almost the double of what the mountain supplied in two centuries and a half. It is really surprising to see a writer, who was long a member of the audience of Lima, so very ill informed; for how can we suppose during 83 years an annual produce of 2,400,000 marcs, when the registers preserved in the treasury of Potosi, prove that during this period the mean sum of the produce seldom amounted to 800,000 marcs.

* *Solorzano Pereira, de Indiarum jure*, t. ii. lib. v. c. i. (edit. Lugd.)

Moreover Acosta * who went over both Americas, and whose work can only be sufficiently appreciated by those who have visited the same places, confirms the assertions of Cieça. He relates that "in the time of the Licenciate "Polo" (consequently before the year 1549), "the fifth amounted to a *million and a half of* "*piastres per annum.* †" He adds that "*not-* "*withstanding the confusion which prevails in the* "*books of accounts of the first years*, we know "from tradition, and from the investigation "carried on by orders of the Viceroy Don "Francisco de Toledo, that the quantity of re- "gistered silver, from 1545 to 1574, amounted "to 76 millions of piastres, and from 1574 to "1585, to 35 millions of piastres, (at 13 *reales* "and one *quartillo*), which in forty years "amounts to 111 millions." These 111 millions of piastres imaginary money (*pesos de minas*), only suppose an annual produce of 555,000 marcs, which differs very little from that of the vein of Guanaxuato. There is no doubt that Acosta speaks of the whole quantity of silver extracted from the mines, and registered at the treasury. He says expressly: *se ha*

* *Historia natural y moral de las Indias*, (Barcelona, 1591) p. 138.

† Which implies a produce of 1,490,000 marcs. (*Herrera*, Decada viii. l. ii. c. xiv.)

metido a quintar, monta lo que se ha quintado. Solorzano translates this passage of the natural history of Acosta, by the following words: *ex Potosiensi fodina extracti sunt centum et undecim milliones.*

The authors whose works contain exaggerated valuations of the quantity of the precious metals which have inundated Spain since the middle of the 16th century, appear to have confounded the value of the produce of the mines with the fifth paid from it. Although they had no knowledge of the official papers which I have here published, they would never have fallen into this error had they only read attentively the works of Acosta, Cieça, and Alonzo Barba. * The latter, who filled the cure of a parish in the town of Potosi, only values the quantity of silver extracted from the Cerro de Potosi, between 1545 and 1636, at 450 millions of piastres of 8 reals; a sum which merely supposes an annual produce of 4,900,000 piastres, or 576,000 marcs, which forms a singular contrast with the 613 millions gratuitously admitted for the first periods from 1545, to 1556. However, Alonzo Barba had no motive for lowering the total produce; on the contrary, he endeavours to prove that an extent of ground of 60 square leagues might be covered with the

* *Barba.* lib. ii. c. i.

number of piastres coined from the silver of Potosi.

The following table exhibits the state of these mines from the period when the fifths were recorded with accuracy :

Produce of the Cerro de Potosi (Hatun-Potocsi).

Periods.	Average Years.		
	Produce in Piastres.	Marcs of silver extracted from the mines.	
		Supposing the piastre at 13½ reals.	Supposing the piastre at 8 reals.
From 1556 to 1566	2,159,216	428,767	- -
1585 1595	7,540,620	1,497,380	887,073
1624 1634	5,232,425	- -	615,580
1670 1690	3,234,580	- -	380,538
1720 1730	1,299,800	- -	152,918
1740 1750	1,850,250	- -	217,676
1779 1789	3,676,330	- -	432,510

As there is some uncertainty respecting the period at which they ceased to reckon by piastres of 13½ reals, of which $5\frac{1}{27}$ make a marc of silver, I prefer giving both valuations of the piastres till 1595 ; and we thus obtain the *maximum* of wealth which we are at liberty to suppose. A passage of the commentaries of Garcilasso, already quoted by us, would lead

one to believe, however, that a few years after 1580, they reckoned at Peru by piastres of 8 reals *de plata*. During the whole period of 233 years, from 1556 to 1789, the mining of Potosi never attained so high a degree of splendour as from 1585 to 1606. For several consecutive years the fifth was a million and a half of piastres, which supposes a produce of 1,490,000, or 882,000 marcs, according as we value the piastre at 13½ or 8 reals. This wealth is the more surprising, as according to Acosta, more than a third of the silver was never registered. After 1606 the produce has been gradually diminishing, and especially since 1694. From 1606 to 1688, however, it was never below 350,000 marcs. During the last half of the 18th century the mountain generally supplied from three to four hundred thousand marcs ; and this produce is undoubtedly still too considerable to allow us to advance with a celebrated author * that the mines of Potosi are no longer worth the trouble of working. These mines in their present state are not the first in the known world ; but we may rank them immediately after the mines of Guanaxuato.

The richness of the ores of Potosi has di-

* *Robertson's History of America*, b. iv. p . 339 and 399.

minished in proportion to the increase of the works in depth. In this point of view, and in many others besides, the Cerro de Potosi bears a great analogy to the mines of Gualgayoc. At the surface of the earth, the veins of Rica, Centeno and Mendieta, which traverse primitive slate, were full, throughout the whole of their width, of a mixture of sulphuretted, red, and native silver. These metallic masses rose in the form of crests (*crestones*), the rocks of the wall and roof having been destroyed either by the action of water, or by some other cause which has changed the surface of the globe. The Veta del Estaño, on the other hand, contained at its surface, only sulphuret of tin, and the horn silver ores only began to appear at great depths. * This mixture of two formations in one vein, exists also on the Old Continent, for example, in several mines of Freiberg in Saxony. † In 1545 ores containing from 80 to 90 marcs per quintal were very common ; but we cannot admit with Ulloa that the whole bulk of ores extracted from the mine, amounted to this degree of wealth. Acosta says expressly, that in 1574 the mean produce was from 8 to 9 marcs, and that the ores which yielded 50

* *Barba*, lib. i. cap. xxxii. p. 56.

† *Werner's Gangtheorie*, p. 248.

marcs per quintal were considered extremely rich. Moreover, according to the report of Don Francisco Texada on the mines of Guadalcanal in Spain, in 1607, the mean produce of the ores of Potosi was not above an ounce and a half. Since the commencement of the 18th century, they reckon only from 3 to 4 marcs per *caxon* of 5000 pounds, or from $\frac{4.8}{100}$ to $\frac{6.4}{100}$ per quintal. The ores of Potosi are consequently extremely poor, and it is on account of their abundance alone, that the works are still in such a flourishing state. It is surprising to see that from 1574 to 1789, the mean richness of the ores has diminished in the proportion of 170 to 1, while the quantity of silver extracted from the mines of Potosi, has only diminished in the proportion of 4 to 1.

From 1545 till 1571 the silver ores of Potosi were all smelted. The knowledge of the *conquistadores* being confined to military affairs, they were unacquainted with the carrying on of metallurgical processes. When their attempts to smelt the ores by means of bellows proved unsuccessful, they adopted the whimsical method employed by the Indians in the neighbouring mines of Potosi, which had been wrought on account of the Inca, long before the conquest ; they established on the mountains which surround the town of Potosi, wherever the wind

blew with impetuosity, portable furnaces, called *huayres* or *guayras* in the Quichua language. These furnaces were cylindrical tubes of clay, very broad, and pierced with a great number of holes. The Indians threw in layers on layers of silver ore, galena, and charcoal; and the current of air which entered at the holes into the interior of the *huayre* quickened the flame, and gave it a great intensity. When they perceived that the wind blew too strong, and that too much fuel was consumed, they carried their furnaces to a lower situation. The first travellers who visited the Cordilleras, all speak with enthusiasm of the impression made on them by the first appearance of more than 6000 fires, which illuminated the summits of the mountains round the town of Potosi. The Indians extracted the galena necessary for their smelting, from a smaller mountain, in the vicinity of the Cerro de *Hatun-Potocsi* called the *child*, or *Huayna Potocsi.** The argentiferous masses which came out of the *huayres* established in the mountains,

* Properly the *Father-mountain* and the *Son-mountain*. The different summits of the Volcan de Pichincha, bear analogous denominations; and it is because the French academicians have not distinguished in their works the old *Rucu-Pichincha* from the young, or *Guagua-Pichincha*, that it is so difficult to find the place of the *academical station* of Bouguer, La Condamine, and Ulloa. (See my *Recueil d'Observations Astronomiques*, vol. i. p. 308.)

were resmelted in the cottages of the Indians, by means of the old process of blowing the fire by ten or twelve persons at once, through tubes of copper, of one or two metres in length, and pierced at the lower extremity with a very small hole. It is easy to conceive what an enormous quantity of silver must have remained in the scoriæ without combining with the lead.

Pedro Fernandez de Velasco, who, it is expressly said by the jesuit Acosta*, "had seen in Mexico how the silver was extracted from the ore by means of mercury," proposed to Francisco de Toledo, viceroy of Peru, to introduce the process of amalgamation into Potosi. He succeeded in his attempts in 1571; and of the eight or ten thousand quintals of mercury produced by the mine of Huancavelica towards the end of the 16th century, more than from six to seven thousand were consumed in the works of Potosi. The ores which during the first years had been considered too poor to be smelted in the *huayres*, were now wrought to advantage.

The abundance of rock salt wrought on the table land of the Cordilleras near Cuchuara, Carangas, and Yocalla, facilitates very much

* *Acosta*, p. 146.

the amalgamation of Potosi. According to the calculation of Alonzo Barba *, there was consumed between 1545 and 1637 the enormous quantity of 234,700 quintals of mercury. From 1759 to 1763, the consumption was between sixteen and seventeen thousand quintals annually. † Towards the end of the 16th century, 15,000 Indians were compelled to work in the mines and amalgamation works of Potosi, and more than 1500 quintals of salt of Yocalla were daily brought to the town. At present there are not more than 2,000 miners, who are paid at the rate of 50 sous ‡ per day. Fifteen thousand llamas, and an equal number of asses are employed in carrying the ore from the mountain of *Hatun-Potocsi* to the amalgamation works. In 1790 there were coined at the mint of Potosi 4,222,000 piastres ||, viz. 299,246 piastres, or 2204 marcs in gold, and 3,293,173 piastres, or 462,609 marcs in silver.

When we reflect on the history of the precious metals, and the interest taken in them by those who engage in investigations of political economy, it will not be deemed surprising that we have so minutely explained those facts, which

* *Barba*, p. 12 and 65.
† *Ulloa Noticias Americanas*, p. 242.
‡ 2*s*. per day. *Trans.*
|| 886,620*l*. Sterling.

may throw some light on the quantity of silver extracted during two centuries and a half from the mines of Potosi. It was necessary to compare the testimonies of the first Spanish authors who visited America; to distinguish between the produce of exportation, and the fifth payable to the crown; and between the piastres, an imaginary coin, used in the beginning of the conquest, and the Peruvian piastres of eight reals. Had we neglected these investigations, which have never been made hitherto, we should have run the risk of overrating the mass of silver imported into Europe since 1492, more than 57 millions of marcs, equal to two thousand five hundred millions of livres tournois. *

IV. The Kingdom of New Grenada produces on an average, 18,300 marcs of gold annually. † The following tables specify the coinage in the mint of Santa Fe, between the 1st of January 1789, and the 31st December 1795, and in the mint of Popayan, between 1788 and 1794.

* 102,040,800*l*. Sterling. *Trans.*
† 12,049 lb. Troy. *Trans.*

I. Gold coined at Santa Fe de Bogota.

Years.	Marcs.	Ounces.	Ochavas.	Tomines.	Value of Gold.		
					Piastres.	Reals.	Quartos.
1789	10,915	2	0	0	1,484,454	0	0
1790	7,345	0	5	0	998,658	5	0
1791	8,318	0	1	4	1,131,251	4	11
1792	8,159	5	3	1	1,109,715	5	24
1793	8,659	3	3	1	1,177,681	5	28
1794	7,327	4	3	4	993,827	6	11
1795	9,310	6	4	4	1,266,272	7	11
Total.	60,013	6	5	2	8,161,862	0	0

Average year 8,573 (marcs of gold or 1,165,980 piastres.

II. Gold coined at Popayan.

Years.	Marcs.	Ounces.	Ochavas.	Value of Gold.	
				Piastres.	Reals.
1788	7,210	4	3	980,634	3
1789	5,945	2	4	808,362	4
1790	7,123	2	6	768,745	0
1791	6,437	2	0	875,466	0
1792	7,344	5	0	998,869	0
1793	7,026	6	5	955,648	5
1794	6,725	1	0	914,617	0
Total.	47,813	0	2	6,502,542	4

Average year 6830 (marcs of gold) or 928,934 piastres.

From 1782 to 1789 the quantity of gold coined at Santa Fe, was at an average, below 7000 marcs annually. During that period the most abundant year was that of 1787, when the produce was 981,655 piastres, or 7218 marcs. * In 1778, the coinage amounted to the value of 693,438 piastres. At Popayan the quantity of coined gold never amounted, between 1770 and 1783, to more than 5800 marcs. In 1778 the gold coinage was only 792,838 piastres; but in 1787 it amounted to 981,655 piastres. The ingots of gold annually exported from the port of Carthagena, are estimated at three or four hundred thousand piastres. During my stay at Santa Fe de Bogota in 1801, the total produce of the gold mines of the kingdom of New Grenada was computed at 2,500,000 piastres †, viz. 2,100,000 piastres as the produce of the two mints of Santa Fe and Popayan, and 400,000 piastres as the exportation of ingots and wrought gold.

All the gold furnished by New Grenada, is

* *Relacion del govierno del Excellentiss. Señor Don Jose de Espeleta, Virrey de el Nuevo reyno de Grenada, para entregar el mando al Señor Don Pedro de Mendinueta, electo Virrey.* This manuscript account in my possession, contains the most minute and accurate statistical information. It is the production of a man of distinguished talents, Don Ignacio Texada, a native of Santa Fe, Secretary of the Viceroyalty.

† 507,000*l.* Sterling. *Trans.*

the produce of stream works (*lavaderos*) established in the alluvial districts. Gold veins have been found in the mountains of Guamoco and Antioquia; but their working is almost entirely neglected. The greatest riches in gold obtained by washing are deposited to the west of the central Cordillera *, in the provinces of Antioquia and Choco, in the valley of the Rio Cauca, and on the coast of the South Sea in the *partido* de Barbacoas. Dividing the auriferous ground into three regions, we may reckon for Choco, 10,800 marcs of gold, or more than the half of the total produce of the viceroyalty of Santa Fe; for the province of Barbacoas, and the Southern part of the valley of Cauca (between Cali and Popayan) 4600: and for the province of Antioquia and the mountains of Guamaco and Simiti, 3400 marcs of gold. We see from this valuation that the alluvial soil, which contains the greatest quantity of gold in dust and grains disseminated among fragments of *greenstone* and porphyrys late (*porphyrschiefer*) extend from the western Cordillera to the shores of the Great Ocean.

It is very remarkable also that platina is seldom found in the valley of Cauca, or to the

* See, as to the division of the Andes into several branches, my *Vues des Cordillères*, Pl. V.

east of the western branch of the Andes, but solely in Choco and at Barbacoas to the west of the sandstone mountains which rise on the western bank of the Cauca. These mountains, of which the height is by no means considerable, separate the famous gold stream works of Novita in Choco, from those of Quilichao and Jelima, situated fifteen leagues to the north of the town of Popayan; and yet a single grain of platina has never been found in the latter places which I examined with the greatest care during my journey to Quito. At Choco, we sometimes find along with gold and platina, hyacinth-zircon, and titanium. This mixture brings to mind the formation of the sands of Espailly in Velay. Near the village of Lloro, some years, ago, a pit was dug in auriferous ground, to examine the inferior beds; and at six metres of depth there were discovered large trunks of petrified wood surrounded with fragments of trap rocks and grains of gold and platina. *

The province of Antioquia, into which we can only enter a-foot or on the *shoulders of men*, contains veins of gold in micaceous slate, at Buritoca, San Pedro, and near Armas; but

* Observation of Don Thomas Valencia at Popayan.

these veins are not wrought for want of hands. Gold is collected in great abundance in the alluvious grounds of Santa Rosa, the Valle de los Orsos, and the Valle de la Trinidad. The number of negro slaves who collect the gold (*negros mazamoreros*) amounted in 1770 to 1462; and in 1778 to 4896 individuals. The gold of Antioquia of which the town of Mompox may be considered as the principal market, is only of the fineness of from 19 to 20 carats. At Barbacoas, is is generally 21½ carats. In Choco, the northern stream works, and those of the district of Zitara, supply a finer gold than the more southern district of Novita. The gold of the mines of Indipurdu is the only gold which rises to 22 carats; for the mean richness of the gold of Choco is from 20 to 21 carats. The produce of the different stream works, is so constant in its mixture, that is is enough for those who carry on the trade in gold dust to know the place where the metal was procured to know its fineness. The finest gold of New Grenada, and perhaps of all America, is that of Giron, which it is affirmed rises to 23 carats and ¾ of a grain. At Marmato to the west of the river Cauca, and to the south of the rivers of the old *Villa de Armas*, a whitish gold is procured which does not exceed 12 or 13 carats and

which is mixed with silver. It is the true *electrum* of the antients. However, although both at Choco and Barbacoas platina generally accompanies gold, they have never yet seen there the *aurum platiniferum*, which perhaps has never existed but in our systems of Oryctognosy.

At Choco, the richest river in gold is the Rio Andageda; which, with the rivers of Quito and Zitasa, forms near the village of Quibdo the great Rio Atrato. All the ground between the Andageda, the Rio de San Juan, which passes near the village of Noanama, the Rio Tamana, and the Rio San Augustin, is auriferous. The largest piece of gold ever found in Choco weighed 25 pounds. The negro who discovered it, fifteen years ago, did not even obtain his liberty. His master presented the *pepita* to the cabinet of the king, in the hopes that the court in recompense, would grant him a *Castilian title*, an object most ardently desired by the creole Spaniards; but he hardly succeeded in obtaining payment of the value of his gold according to weight. It is said that a piece of gold was found in Peru near *la Paz* in 1730, of the weight of 45 pounds.

Under the viceroyship of the Archbishop Gongora, an enumeration was made of the

negroes employed in procuring gold at Choco* ; and they amounted in 1778 only to 3054. In the valley of Cauca there are 8000. The province of Choco might alone produce more than twenty thousand marcs of gold from washing, if in peopling this region, which is one of the most fertile of the New Continent, the government would turn its attention to the progress of agriculture. The richest country in gold is that in which scarcity is continually felt. Inhabited by unfortunate African slaves, or Indians who groan under the despotism of the Corregidors of Zitara, Novita, or Taddo, the province of Choco remains what it was three centuries ago, a thick forest, without trace of cultivation, without pasturage, and without roads. The price of commodities is so exorbitant there, that a barrel of flour of the United States sells from 64 to 90 piastres ; the maintenance of a muleteer costs a piastre, or a piastre and a half per day ; and the price of a quintal of iron amounts in time of peace to 40 piastres. This dearth ought not to be attributed to the accumulation of the representative signs, which is very inconsiderable ; but to the enormous difficulty of carriage, and to that miserable state of

* *Relacion del estado del nuevo reyno de Grenada que hace el Arzobispo— Obispo de Cordova a su successor et Ex. Fray Don Francisco Gil y Lemos.* 1789, (M S.)

things in which the whole population consumes without producing.

The kingdom of New Grenada possesses veins of silver extremely rich in the Vega de Supia*, to the north of Quebraloma, between the Cerro Tacon, and the Cerro de Marmato. These mines which supply both gold and silver, were only discovered within these ten years. The operations were interrupted, in consequence of a law-suit between the proprietors, at the very time when the ores were found in the greatest quantity. The working of the old silver mines, of Pamplona, and Saint Anne, near Mariquita, was resumed with zeal, at the period when the Court of Madrid appointed Don Juan Jose D'Elhuyar, director of the mines of the viceroyalty of Santa Fe. The repository of argentiferous ores of Saint Anne, forms a bed in gneiss. I visited the mine of Manta, the produce of which contains on an average six ounces to the quintal. M. D'Elhuyar the brother of the director of the mines of Mexico, had established an amalgamation work with four barrels like that of Freiberg. The works were conducted with great intel-

* Mina de los Morenos or Chachafruta. From Carthago to la Vega de Supia, it is in a straight line only 20 leagues.

ligence; but as the quantity of silver between 1791 and 1797 only amounted to 8700 marcs, while the expenses* amounted to 216,000 piastres, the viceroy ordered the mine to be abandoned. It is to be hoped that in better times, the government will again endeavour to resume these works, as well as the works of Santo Christo de las Laxas, and the Real de Bocaneme, between the Rio Guali and the Rio Guarino, which formerly furnished considerable quantities of silver.

Resuming the results we have obtained, we find that the total produce of the gold and silver mines of the Spanish Colonies, amounts to the sum of 40,600 marcs in gold†, and 3,206,000 marcs of silver, Castille weight.‡ These data differ very little from those communicated by me to M. Heron de Villefosse, which he published in his interesting work on the mineral wealth of the principal powers of Europe. The following table was drawn up from the valuable information which I obtained more recently from Spain, and the kingdom of New Grenada.

* Expenses of subterraneous works, expenses of amalgamation, and construction of amalgamation works.

† 25,026 lb. troy. *Trans.*

‡ 1,976,290 lb. troy. *Trans.*

Annual produce of the Gold and Silver on which the fifth has been paid.

Names of great Political Divisions.	Fine Gold, Marcs of Castille.	Fine Silver, Marcs of Castille.	Value of Gold and Silver in Piastres.
Viceroyalty of New Spain - - - -	7,000	2,250,000	22,170,740
Viceroyalty of Peru	3,400	513,000	5,317,988
Capitania General of Chili - - - -	10,000	29,700	1,737,380
Viceroyalty of Buenos Ayres - - -	2,200	414,000	4,212,404
Viceroyalty of New Grenada - - -	18,000	Little.	2,624,760
Total - -	40,600	3,206,700	36,063,272

In this table the gold is valued at 145 $\frac{82}{100}$ piastres, and the silver at 9 $\frac{4}{75}$ piastres per marc of Castile. It exhibits the quantity of precious metals extracted from the mines, and registered in the royal treasury; and it confirms the assertion of the Count de Campomanes*, who, in 1775, estimated the importation of gold and silver into Spain at 30 millions of piastres; but it merely indicates the *maximum*, which we may suppose to have been furnished by the Spanish colonies. Let us examine what ought to be added for the metals which are smuggled. Hitherto very exaggerated ideas have been entertained respecting the quantity of gold and silver which does not pay the fifth,

* *Educacion Popular*, T. ii. p. 331.

and which has sometimes been computed at the half, or a third of the total produce, without reflecting that contraband trade varies very much in its activity, according to the localities of different provinces. I shall state here what information I could procure on the spot at Mexico, New Granada, and Peru.

New Spain has only two ports, by which its productions are exported. The bad state of the coasts renders contraband trade much more difficult in that country than in the provinces of Cumana, Caracas, and Guatimala. The quantity of unregistered silver embarked at Vera Cruz, and Acapulco, either for the Havannah and Jamaica, or for the Philippine Islands and Canton, does not probably exceed the sum of 800,000 piastres; but this illicit trade will increase in proportion as the population of the United States shall approach the banks of the great *Rio del Norte*, and when the west coast, that of Sonora and Guadalaxara, shall be more frequently visited by English and Anglo-American vessels. When the commerce with China and Japan shall be freed from the fetters of the odious monopoly under which it at present labours, an immense quantity of silver will flow westwards into Asia. The precious metals are commodities which are transported to those places where they are dearest. In Japan*, which abounds in gold, this metal is to silver as eight or nine to one. In China an ounce of gold is purchased for 12 or 13 ounces of silver. In Mexico the proportion of the two precious metals is as $15\frac{1}{2}$ to 1; from whence it follows, that it is much more profitable to carry silver than gold to Manilla, Canton, and Nagasaki. I have made no mention yet of the exportation of wrought plate (*plata labrada*), because, according to the registers of Vera Cruz, it never exceeds the sum of twenty or thirty thousand marcs of silver.

In the kingdom of New Grenada, the fraudulent exportation of the gold of Choco has very much increased since the navigation of the Rio Atrato was declared free. Gold dust, and even ingots, in place of being conveyed by Cali or Mompox to the mints of Popayan and Santa Fe, take the direct route of Carthagena and Portobello, from whence they flow into the English colonies. The mouths of the Atrato and the Rio Sinu, where I remained at anchor in the month of April, 1801, serve as stations for smugglers. The laws which from time to time permit the importation of negroes from Africa, and flour from Philadel-

* *Voyage au Japon*, de Thunberg (edit. de Langlès) T. ii. p. 263.

phia in foreign vessels, are favourable to this contraband trade. According to what information I could obtain from those who deal in gold dust (*rescatadores*) at Carthagena, Mompox, Buga, and Popayan, it would appear that we may estimate the quantity of gold supplied by Choco, Barbacoas, Antioquia, and Popayan, on which the fifth has not been paid, at 2500 marcs.

In Peru, the exportation of silver on which the fifth has not been paid, is not so much carried on by the South Sea coast, which is frequented by the spermaceti whale-fishers*, as to the east of the Andes, by the Amazon river. This great river connects two countries, where a great disproportion prevails between the relative value of gold and silver. Brazil is almost as profitable a market for the silver of Peru, as China for the silver of Mexico, A fifth, and perhaps even a fourth, of all the silver extracted from the mines of Pasco, (*Yauricocha*) and Chota (*Gualgayoc*), is exported in contraband by Lamas and Chachapoyas, in descending the river Amazons. There are persons at Lima who believe that on quickening the trade on that river, the fraudulent exportation of silver would become still greater. This prejudice has been very pernicious for

* See p. 87. of this vol.

the fine provinces which extend along the eastern declivity of the Cordilleras, fertilized by the Guallaga, the Ucayale, the Puruz, and the Beni. They forget that the wildness and solitude of these countries facilitate very much the operations of the smugglers. We shall estimate the unregistered silver of Peru at 100,000 marcs.

In Chili the gold which pays the fifth is to that which does not, according to Ulloa, in the proportion of 3 to 2. We shall only compute it at a fourth of the total produce. Estimating the fraudulent exportation of silver in the kingdom of Buenos Ayres at a sixth, or 67,000 marcs, and adding, with M. Correa de Serra, for the total produce of Brazil, where alluvial mines are only yet wrought, nearly 30,000 marcs of gold, we shall be able to exhibit in the following table, the whole produce of all America in gold and silver.

Annual produce of the Mines of the New Continent, at the beginning of the 19th century.

Names of Great Political Divisions.	Gold.		Silver.		Value of Silver in Piastres.
	Marcs of Castille.	Kilogr.	Marcs of Castille.	Kilogr.	
Viceroyalty of New Spain -	7,000	1,609	2,338,220	537,512	23,000,000
Viceroyalty of Peru - -	3,400	782	611,090	140,478	6,240,000
Capitania General of Chili	12,212	2,807	29,700	6,827	2,060,000
Viceroyalty of Buenos Ayres - - -	2,200	506	481,830	110,764	4,850,000
Viceroyalty of New Grenada - - -	20,505	4,713	- - -	- -	2,990,000
Brasil - -	20,900	6,873	- - -	- -	4,360,000
Total	75,217	17,291	3,460,840	795,581	43,500,000

The total produce of the mines of the New World consequently amounts at this day to 17,000 kilogrammes of gold*, and 800,000 kilogrammes of silver†, reckoning the mark of Castile, by which the produce of the mines in the Spanish colonies is estimated, to the marc of France‡ in the proportion of 541 to 576, and the kilogramme at 4

* 45,580lb. troy. *Trans.*

† 2,145,003lb. troy. *Trans.*

‡ *Bonneville Traité des Monnies*, 1806. p. 31.

marcs, 5 gross, 35.15 grains, old French weight. The tin furnished by all Europe weighs only three times as much as the quantity of silver annually extracted from the mines of America. It may be seen also from the preceding table, that it is erroneous to attribute to Brasil the greatest part of the gold with which the Old Continent is supplied by the New. The Spanish colonies supply nearly 45,000 marcs of gold, while only 30,000 are extracted from the alluvial regions of Brasil. If the government of Santa Fe de Bogota begin seriously to turn its attention to the population and agriculture of Choco, the extraction of gold in New Grenada will in a very few years rival that of Brasil. The author of the immortal work on the *Wealth of Nations**, values the quantity of gold and silver annually imported into Cadiz and Lisbon at only six millions of pounds sterling, including not only the registered gold, but also what may be supposed to be smuggled. This estimate is too small by two-fifths.

Bringing together the results which we have just obtained for the New World, with

* According to Meggens (*Postscriptum du Negociant Universel*, 1756, p. 15.) the importation into Spain and Portugal was from 1747 to 1753 at an average 5,746,000 pounds sterling.

those which are the fruit of the laborious researches of M. Heron de Villefosse and M. Georgi*, we find the following data:

* *Geo. phys. Beschreibung des Russischen Reichs*, 1797, Th. 6. p. 368. M. Georgi's valuation is for the year 1796. The produce of the mines of Koliwan has doubled, and that of the mines of Nertschink has diminished more than a third between 1784 and 1794.

Annual produce of the Gold and Silver Mines of Europe, Northern Asia, and America.

Great Political divisions.	Gold.			Silver.			
	Marcs of France.	Kilogr.	Value of gold in francs.	Marcs of France.	Kilogr.	Value of silver in francs.	Value of gold and silver in piastres.
Europe - - - - -	5,300	1,297	4,467,444	215,200	52,670	11,704,444	16,171,888
Northern Asia -	2,203	538	1,853,111	88,700	21,709	4,824,222	6,677,333
America - - -	70,647	17,291	59557 889	3,250,547	795,581	176,795,778	236,353,667
Total - -	78,147	19,126	65,878,444	3,554,447	869,960	193,324,444	259,202,888

In this table the gold is valued at 3444 francs 44 centimes, and the silver at 222 francs 22 centimes per kilogramme. It indicates the quantity of the precious metals which annually enters into circulation among the civilized nations of Europe. It is impossible to value the mass of gold and silver at present worked on the whole surface of the globe; for we are absolutely ignorant of what is produced in the interior of Africa, in Central Asia, Tonquin, China, and Japan. The trade in gold dust, carried on on the eastern and western coasts of Africa, and the information derived by us from the antients respecting the countries with which we have no longer any communication, might lead us to suppose that the countries to the south of the Niger are very rich in precious metals. We may make the same supposition respecting the high chain of mountains extending to the north-east of the Paropamisus towards the frontiers of China. The quantity of ingots of gold and silver formerly exported by the Dutch from Japan, proves, that the mines of Sado, Sourouma, Bingo, and Kinsima, are equal in wealth to several of the mines of America.

Of the 78,000 marçs of gold, and 3,550,000 marcs of silver, French weight, annually extracted since the end of the 18th century,

from all the mines of America, Europe, and Northern Asia, America alone furnishes 70,000 marcs of gold, and 3,250,000 marcs of silver, and consequently $\frac{9}{10}\frac{0}{0}$ of the total produce of gold, and $\frac{9}{10}\frac{1}{0}$ of the total produce of silver. The relative abundance of the two metals differ, therefore, very little in the two continents. The quantity of gold drawn from the mines of America is to that of silver as 1 to 46; and in Euorpe, including Asiatic Russia, the proportion is as 1 to 40.

These results may serve to throw some light on the great problem of political economy, examined by Mr. Smith in the eleventh chapter of the first book of his work, where he treats of the causes of the fluctuation between the relative value of the precious metals. This celebrated author supposes, that for every ounce of gold there are more than 22 ounces of silver imported into Europe. If this supposition were correct, the Old Continent ought to receive from the New only 1,554,000 marcs of silver, instead of 3,250,000, which it really receives. However, the greater the abundance of gold in proportion to silver, the more we must be inclined to admit with Mr. Smith, that the proportion between the respective values of the two metals does not alone depend on the quantity in the market. Since the discovery of America to the

present day, the value of silver has fallen so much in the western parts of Europe, that the proportion* between that metal and gold, which, at the end of the 15th century, was as 1 to 11, or 1 to 12, is now as 1 to 14½, and even as 1 to 15⅝. This change would not have taken place if the increase of the respective masses of the two metals had been at all times as uniform† as at present. From what has just been stated, it is not accurate to advance, as has frequently been done, that the fecundity of the silver mines of America surpasses that of the mines of the Old Continent in much greater proportion than the gold mines. It is true that of the 70,000 marcs of gold annually supplied by America, five-sixths are derived from washing places, established in alluvial soil; but these washing places (*lavaderos*) are surprisingly uniform in their produce; and all who have visited the Spanish or Portuguese colonies know that the exportation of gold from America must considerably increase with the progress of population and agriculture.

Till 1545, when the Cerro de Potosi began

* Under Philip-le-Bel a marc of gold was current for 10 marcs of silver. In Holland, the proportion in 1336, was as 10½ to 1. In France it was in 1388, as 10⅝ to 1. (*Recherches sur le Commerce*, Amsterdam, 1778, t. ii. p. ii. p. 142.)

† Nine-tenths.

to be worked, Europe appears to have received much more gold than silver from the New Continent. Five-sixths of the booty which Cortez acquired at Tenochtitlan, and the treasures at Caxamarca and Cuzco consisted in gold; and the silver mines of Porco in Peru, and Tasco and Tlapujahua in Mexico, were very feebly wrought in the times of Cortez and Pizarro. It is only since 1545 that Spain has been inundated with the silver of Peru. This accumulation produced the greater effect, as the civilization of Europe was then more concentrated; as communication was less frequent; and as a smaller portion of the precious metals were re-exported for Asia. About the middle of the 16th, and the beginning of the 17th century, the proportion between gold and silver rapidly changed, especially in the south of Europe. In Holland it was still, in 1589, as 11½ to 1: but under the reign of Louis XIII. in 1641, we find it already in Flanders, as 12½ to 1; in France, as 13½ to 1; and in Spain as 14 to 1, and even beyond that. The extraction of gold has prodigiously increased in America since the end of the 17th century; and although the auriferous grounds of Brazil have been partly known ever since 1577, yet the gold-stream works only commenced in the reign of Peter II. In the time of Charles V. a quantity of gold of

forty or fifty thousand marcs would have been sufficient to produce a sensible change in the proportion between gold and silver in Europe. On the other hand, this influence was hardly felt in the beginning of the 18th century, when commercial relations were very much multiplied. The gold of Brazil, divided over a vast extent of country, could not produce the effect on the price of silver which it would have produced by a rapid accumulation on a single point of the globe.

We shall now enter upon a very important question, which has been very variously treated in works of political economy: namely, the quantity of gold and silver which has flowed from the New Continent into the Old, since 1492 to this day. Instead of examining the progress of mining in America, and estimating the produce of the mines of each colony at different periods, they have laid down a hypothesis of a certain number of millions of piastres, which have been arbitrarily enough supposed to have been introduced annually into Portugal and Spain, during three centuries. It might have been easily foreseen that in calculating according to this principle, they would obtain results differing from one another in several thousands of millions of livres tournois, according as the annual importation was taken at ten or twelve millions of livres only, either below or above the truth. Besides,

the greatest number of the most celebrated authors*, instead of investigating for themselves, were satisfied with copying the valuations of Don Geronimo de Ustariz, as if merely to quote the particular opinion of a Spanish author was sufficient to inspire confidence. Before communicating my own results, let us examine those calculations which have been hitherto before the public.

Ustariz, in his excellent *treatise of commerce and navigation*†, founds his calculations on those of Don Sancho de Moncada and Don Pedro Fernandez de Navarete. The former, who was professor in the University of Alcala, affirms vaguely, that "according to a repre-"sentation made to the king, there have entered "into Spain, between 1492 and 1595, in gold "and silver extracted from the mines of "America, two thousand millions of piastres; "that at least the same quantity had entered "without being registered; and that of all "the gold and silver it would be difficult to "find in Spain two hundred millions, one "hundred in coin, and another hundred in "household furniture." Ustariz adds to these two thousand millions, the quantity imported

* Forbonnais, Raynal, Gerboux, and the judicious author of the *Recherches sur le Commerce* (Amst. 1778.)

† Edition of Paris, 1753. p. 11. *Toze, kleine schriften*, 1791, p. 99.

into Spain, between 1595 and 1724, which he estimates at 1536 millions; so that the total produce of Spanish America in gold and silver, from 1492 to 1724, amounted, according to this author, to 5536 millions of piastres.

It is easy to prove that this calculation does not rest on very solid foundations. Four thousand millions divided among one hundred and three years, from 1492 to 1595, suppose an average annual produce of more than 38 millions of piastres. Now, we learn from the history of the mines of America, that the quantity of gold and silver introduced into Spain between 1492 and 1535 was very small, and cannot be estimated at more than 130 or 140 millions. If, however, we admit 12 millions of piastres per annum for this first period, the sum which Ustariz fixes for the period between 1595 and 1724, we shall find that the annual produce between 1535 and 1595 ought at least to be 58 millions. All the estimates are four or five times too high, as we may be convinced of by casting our eyes over the registers of Potosi, and recollecting that the mines of New Spain, till the beginning of the eighteenth century, never yielded above three millions of piastres per annum. Moreover, Garcilasso and Herera, in speaking of the great wealth of the mines of the New Continent, expressly say, that towards the end of the

sixteenth century, from ten to twelve millions of piastres annually entered Spain by the mouth of the Guadalquivir. The estimates in round numbers of thousands of millions, far from being entitled to be considered as the fruits of accurate research, are merely the result of an approximate calculation. Hence every author has thought himself entitled to fix on different quantities.

Solorzano affirms*, on the authority of Davila, that Spain received from America, from its discovery in 1492 to 1628, fifteen hundred millions of registered piastres, a sum which differs nearly by one half from that adopted by Ustariz. On the other hand, we find in the political treatise of Navarete†, that between 1519 and 1617, according to registers, there was imported 1536 millions. According to this valuation, we attribute to the period of 98 years a smaller sum of piastres than what Solorzano and Davila admit for the period of 136 years, which is a contradiction so much the greater, as the one of these periods composes a part of the other.

Raynal, in the first editions of his celebrated work on the settlements in the Indies‡, es-

* *De Indiarum jure*, T. II. p. 846. *Hist. magna Matritensis*, p. 472.

† *De la conservacion de las Monarquias*, Disc. XXI.

‡ Compare the changes made in B. viii. § xlii.; B. x. § liv.

timated the gold and silver imported from America into Europe, since the discovery of the New World, at nine thousand millions of piastres; but in 1780 he reduced this sum to five thousand millions. He supposes that the annual importation of registered gold and silver into Spain, on an average of eleven years, from 1754 to 1764, only amounted to 13,984,185 piastres; while we know, from the registers preserved in the mint of Mexico, that at that very period New Spain alone produced annually nearly twelve millions of piastres. I cannot conceive how an author, full of sagacity and generally well informed, can have allowed himself to form such erroneous notions respecting the commerce in the precious metals. Raynal gives tables apparently the result of very extensive labour: he estimates, separately, the quantities of gold and silver from each part of the colonies; and notwithstanding this apparent accuracy, a great number of these calculations rests on no very solid foundation. He affirms* that Spain drew, from 1780, every year from the continent of America, 89,095,052 livres in gold and silver, or 16,970,484 piastres: because, from an average year taken during the period from 1748 to 1753, there was imported:

* *Hist. Philosophique*, Geneva Edn. 1780, T. II. p. 339.

	Liv. Tournois.	Piastres.
From New Spain -	44,106,047	8,418,294
From Carthagena or New Grenada -	14,087,304	2,683,296
From Lima or Peru	25,267,849	4,812,924
From Buenos Ayres or the kingdom of La Plata -	5,304,705	1,010,420
From Caracas	239,144	45,551
Total of an average year	89,095,049	16,970,485

It is surprising to see Raynal confound the produce of 1750 with that of 1780: for during that space of thirty years, the exportation of silver from Mexico had increased more than a fourth; and the mines of South America, far from being exhausted, were become more abundant. In 1780 there was coined, at the mint of Mexico alone, the sum of 17,514,263 piastres; while the Abbé Raynal estimates the total produce of the mines of Spanish America, at only eighteen millions. He ought to have known, from the testimony of a statesman thoroughly informed respecting the commerce of Spain*, that in 1775 the total produce had already risen to 30 millions of piastres, or to 157,500,000 livres tournois per annum.

* *Campomanes, Discurso sobre la Educacion popular de los artesanos*, Vol. ii. p. 331.

With respect to the quantity of precious metals received by Spain from her colonies, since the discovery of America, Raynal fixes it at 25,570,279,924 liv., or 4,870,529,509 piastres. This calculation, which would inspire more confidence if the sums were expressed in round numbers, is sufficiently accurate; and it proves, that even in setting out from the falsest data, we may sometimes, by fortunate computations, arrive at results very near the truth.

Adam Smith, in his classical work on the causes of the wealth of nations *, estimates the silver exported from the New Continent into Cadiz and Lisbon, at six millions sterling, or 26½ millions of piastres per annum; but this estimate was too small by two-fifths, even in his time, in 1775. The English author followed the calculations of Meggens; according to whom, during 1748 and 1753, Spain and Portugal received annually, at an average, in registered precious metals, £5,746,000 sterling, or 25,337,000 piastres. Reckoning four millions for the importation of gold from Brazil, we find, according to Meggens, 21 millions of piastres for the Spanish colonies alone; and, consequently, three millions more than Raynal allows for the year 1780 Mr. Garnier, the learned commentator on

* Book I. Chap. I.

Smith *, who has displayed the greatest accuracy in his researches, estimates the produce of the gold and silver mines of Spanish America, in 1802, at 159 millions of livres tournois, or 30,285,000 piastres; a sum which approaches nearer to the truth than all the calculations to be found in other works on Political Economy.

Robertson estimates, in his History of America, the amount of the precious metals imported into Spain, between 1492 and 1775, at the enormous sum of two thousand millions sterling, or 8800 millions of piastres; and what is more singular, this justly celebrated author considers his calculation as founded on very moderate suppositions, though he estimates the annual produce of the mines, during 283 consecutive years, at four millions sterling, and the amount of the contraband, during that period, at 968 millions.† When we compare these data with those of the work of Ustariz, we observe that the sums of the Spanish author are lower by one half.

In the *Recherches sur le Commerce*, published at Amsterdam in 1778‡, the amount of gold and silver exported from Spanish

* T. V. p. 137.

† *History of America*, Vol. iv. p. 62.

‡ Liv. i. chap. x. (T. i. P. ii. p. 124.)

America, between 1674 and 1723, is estimated at 672 millions of piastres. Reckoning at the same rate the 283 years between 1492 and 1775, and adding a third for the contraband, we find the total of all the metals imported into Spain 5072 millions of piastres. The same author estimates the gold imported from Brazil, since the discovery of that country, at 1350 millions; a sum which appears nearly double too much, as we shall prove in the sequel of the discussion.

Mr. Necker*, in his researches respecting the existing specie in France, estimates the gold and silver received at Cadiz and Lisbon, from 1763 to 1777, at 1600 millions of livres tournois, or 304,800,000 piastres. According to this hypothesis, the total exportation of precious metals from the two Americas would have amounted only to 21½ millions of piastres per annum; while that to Spain alone, according to authentic information, was more than 30 millions.† On the other hand, M. Gerboux, in his *Discussions sur les effets de la démonétisation de l'or*‡, estimates the importation of

* *Sur le commerce des grains*, Liv. ii. chap. v. *De l'administration des finances*. T. iii. chap. viii. p. 71.

† *Encyl. méthod. Economie polit.* T. ii. p. 324.

‡ Pag. 36, 66, 69, 70.

gold and silver into Europe in livres tournois, as follows:

From 1724 to 1766—4000 millions.
1766—1800—4000
1789—1803—1500

From whence it would follow that the annual importation, from 1724 to 1803, amounted to 21 millions of piastres.

Uniting in one point of view the results of all these calculations, which are founded on nothing but mere conjectures, we find that the mass of registered precious metals imported into Europe, is according to

Names of Authors.	Periods.	Piastres.
Ustariz - - -	1492—1724	3536 millions.
Solorzano - -	1492—1628	1500
Moncada - -	1492—1595	2000
Navarete - - -	1519—1617	1536
Raynal - - -	1492—1780	5154
Robertson - -	1492—1775	8800
Necker - - -	1763—1777	304
Gerboux - - -	1724—1800	1600
The author of *Recherches sur le Commerce* -	1492—1775	5072

To avoid as much as possible in these researches the causes of error, which are but too

numerous, I shall follow a different course from that adopted by the writers above mentioned. I shall first state the quantity of gold and silver, which, according to the records of the mints and the royal treasury, we know to have been extracted from the mines of Mexico and Potosi; I shall add, from the historical knowledge which I acquired respecting the state of the Mexican mining operations, the amount furnished by each metalliferous region of Peru, Buenos Ayres, and New Grenada; and I shall distinguish what has been registered from what has been fraudulently introduced. Instead of estimating, as has hitherto been done, the total produce of this contraband trade, at a third or a fourth of the whole of the registered metals, I shall make partial estimates, according to the position of each colony and its relations with the neighbouring countries. When we wish to judge of a distance which we cannot measure with precision, we are sure of committing errors of less consequence if we divide the whole extent into several parts, and if we compare each of these with objects of a known greatness.

1. Quantity of Registered Gold and Silver extracted from the mines of America between the years of 1492 and 1803.

A. SPANISH COLONIES.

	Piastres.
The kingdom of New Spain has furnished the mint of Mexico, between 1690 and 1803, according to the register already given, with - - - -	1,353,452,000
The mines of Tasco, Zultepec, Pachuca, and Tlapujahua, are almost the only ones which were worked immediately after the destruction of the city of Tenochtilan in 1521, and from that memorable period till 1548. As the quantity of gold and silver coined in the beginning of the 18th century did not exceed five millions of piastres per annum, I reckon from the conquest by Hernan Cortez till 1548 for the total produce of Mexico - -	40,500,000
Carried over	1,393,952,000

	Piastres.
Brought over	1,393,952,000
In 1548 the mines of Zacatecas began to be worked, and the mines of Guanaxuato in 1558; and nearly at the same period amalmagation was invented by Medina. We may reckon from 1548 till 1600 at least two millions, and from 1600 till 1690 three millions per annum - - - - - - - - - -	374,000,000
The mines of Potosi, supplied from their discovery in 1545 till the year 1803, 1095½ millions of piastres, or 128,882,000 marcs; namely, from 1545 to 1556, nearly - - - - - -	127,500,000
From 1559 to 1789, according to the registers of the treasury already given - - - - - - -	788,258,500
Add, on account of the value of the *peso de minas*, from 1556 to 1600 - - - - - - - -	134,000,000
Produce of Potosi, from 1789 to 1803 - - - - - - - - - -	46,000,000
Carried over	2,863,710,500

	Piastres.
Brought over	2,863,710,500
The mines of Pasco or Yauricocha, discovered in 1630, yielded up to 1803 nearly 300 millions of piastres, or 35,300,000 marcs; namely, from 1630 to 1792, at 200,000 marcs per annum - - - - - - - -	274,400,000
From 1792 to 1801, according to the registers - - - - -	21,501,600
Produce of the Cerro de Yauricocha, from 1801 till 1803	3,400,000
The mines of Gualgayoc, discovered in 1771, yielded up to 1773 nearly 170,000 marcs of silver per annum - - - -	4,300,000
From 1774 till 1802, for the mines of Gualgayoc, Guamachuco and Couchucos - - -	185,339,900
Add for 1803 - - - - - - -	504,000
I estimate the produce of the mines of Huantajaya, Porco, and other less considerable Peruvian mines, from the 16th century till 1803, at 150,000 or 200,000 marcs of silver per annum - - - - - - - -	350,000,000
Carried over	3,703,156,000

	Piastres.
Brought over	3,703,156,000
Choco was peopled in 1539; the province of Antioquia, then inhabited by cannibals, was conquered in 1541. The alluvial mining tracts of Sonora and Chili began only very late to be worked. If we reckon 12,000 marcs of gold for the total produce of the Spanish Colonies, not including the kingdom of New Spain, we may add - - - - - - - -	332,000,000
Registered Gold and Silver of the Spanish Colonies, from 1492 to 1803 - - - -	4,035,156,000

B. PORTUGUESE COLONIES.

Raynal supposes, for the first sixty years, a produce the double of the present. He admits, that according to the registers of the fleets, since the discovery of the mines of Brazil till 1555, there has come into Europe, in gold, the value of - - - - - - - - - - -	480,000,000
Carried over	480,000,000

	Piastres.
Brought over	480,000,000
From 1756 to 1803, reckoning only an annual produce of 32,000 marcs - - - - - -	204,554,000
Registered gold of the Portuguese Colonies, from the discovery of Brazil till 1803	684,544,000

II. Gold and Silver not registered, extracted from the mines of the New Continent, from 1492 to 1803.

A. SPANISH COLONIES.

I reckon for New Spain, where the furtive extraction was very considerable till the middle of the eighteenth century, a seventh - - - - - - - - -	260,000,000
For Potosi, the fourth of the total produce, on account of the enormous contraband at the beginning of working the mines - - - - - - - - -	274,000,000
Pasco, Gualgayoc, and the rest of Peru, where the silver is carried off on the Amazon river towards Brazil - - -	200,000,000
Carried over	734,000,000

	Piastres.
Brought over	734,000,000
For the gold of Chili, New Granada, and the kingdom of Buenos Ayres - - - - - -	82,000,000

B. PORTUGUESE COLONIES.

For the gold of Brazil - - -	171,000,000
Unregistered Gold and Silver, from 1492 to 1803 - - -	987,000,000

RECAPITULATION.

Value of Gold and Silver extracted from the mines of America, from 1492 to 1803.

Registered (No. I.)	From the Spanish Colonies - - -	4,035,156,000
	From the Portuguese Colonies - - -	684,544,000
Not Registered (No. II.)	From the Spanish Colonies	816,000,000
	From the Portuguese Colonies - - -	171,000,000
	Total	5,706,700,000

This sum, which I believe myself warranted in fixing on, differs more than sixteen thousand millions of francs from the sum stated by Robertson. It is not surprising that it approximates the estimates of several other writers; for it is with numbers in political economy, as with the positions fixed by astronomers: when we have first observed the longitude of a place, we are sure to find, amid the great number of maps in which all the points are placed at random, one which indicates the true position.

It appears, then, that of the 5,706,700,000 piastres, or 29,960,175,000 livres tournois, furnished in gold and silver from 1492 till 1803, or in the space of 311 years, we owe:

Political Divisions.	Piastres.	Livres Tournois.	Pounds Sterling.
To the Spanish Colonies	4,851,200,000	25,468,800,000	1,039,542,690
To the kingdoms of New Spain	2,028,000,000	10,647,000,000	434,571,358
To the kingdom of Peru and Buenos Ayres - - -	2,410,200,000	12,653,550,000	516,471,344
To the kingdom of New Grenada	275,000,000	1,443,760,000	58,928,967
To Chili - - - -	138,000,000	724,500,000	29,571,021
To the Portuguese Colonies	855,500,000	4,491,375,000	183,688,744
Total	5,706,700,000	£29,960,175,000	£1,223,231,434

As the Cerro del Potosi belongs, from its position, to the Cordilleras of Peru, I have brought together in this table the mines situated on the ridge of the chain of the Andes, from the 6° to the 21° of south latitude, for a length of 500 leagues. The mining districts of Mexico, comprehended between the 16° and 31° of north latitude, at present supply twice as much silver as the two viceroyalties of Peru and Buenos Ayres; and this tract is only 450 leagues in length. The following table specifies the proportion between the gold and silver drawn from the mines of the New Continent, from their discovery till 1803.

Political Divisions.	Marcs, Castile weight.	Piastres.
Gold - - -	9,915,000	1,348,500,000
From the Portuguese Colonies - - -	6,290,000	855,500,000
From the Spanish Colonies - - -	3,625,000	493,000,000
Silver - - -	512,700,000	4,358,200,000
Total		5,706,700,000

According to this estimate, which is merely an approximate, the mass of silver furnished by the Cordilleras of America for three centuries, amounts to 117,864,210 kilogrammes * in weight.

* 316,023,883 lb. troy.

It would form a solid sphere of a diameter of 27.8 metres *, or $85\frac{1}{20}$ Paris feet. When we recollect that the iron extracted from the mines of France alone amounts to 225 millions of kilogrammes per annum, we see, that with respect to the relative abundance, or distribution of the substances in the exterior crust of the globe, silver stands to iron nearly in the relation of magnesia to silica, or baryta to alumina.

We must not, however, confound the quantity of precious metals extracted from the mines of the New Continent with what has really flowed into Europe since the year 1492. To judge of this last sum, it is indespensable to estimate, 1st, The gold and silver found at the period of the conquest among the natives of America, and which became the spoil of the conquerors; 2dly, What has remained in circulation in the New Continent; and 3dly, What has passed directly to the coasts of Africa and Asia, without touching Europe.

The conquerors found gold not only in the regions where it is still produced, as in Mexico, Peru, and New Grenada, but also in countries of which the rivers actually appear to us very poor in auriferous sands. The natives of Florida, Saint Domingo, and the island of

* 91.206 feet, English. *Trans.*

Cuba, of Darien, and the coast of Paria, had bracelets, rings, and necklaces of gold; but it is probable that the greatest part of that metal was not derived from the countries in which these tribes were found, at the end of the fifteenth century. In South America as well as in Africa, commercial communications existed, even among the hordes the most remote from civilization. Coral and beads of sea-shells were frequently found in the possession of men who lived at a great distance from the coast. We ascertained, during our journey on the Orinoco, that the famous Mahagua stone, or the Amazons jade, is conveyed, by means of an exchange established among different tribes of savages, from Brazil to the banks of the Carony, inhabited by the Caraib Indians. Besides, it is to be remarked, that the people found by the Spaniards in Darien, or the island of Cuba, had not always inhabited the same countries. In America the great migrations have taken place from the north-west, to the south-east: and frequently whole tribes have been forced by wars to quit the mountains, and settle in the the plains. We can conceive, therefore, in what manner the gold of Sonora, or the valley of the Rio Cauca, might have been found among the savages of the Darien, or at the mouths of the river Madalena. Besides, the smaller the population the more deceitful the appear-

ance of wealth. The accumulation of gold is particularly striking in countries where all the metal possessed by the people is converted into objects of ornament. We must not, then, judge of this pretended wealth of the mines of Cibao, of the coast of Cumana, and the isthmus of Panama, from the recital of the first travellers. We must recollect that rivers become less auriferous, in proportion as during the course of ages, their course becomes less rapid. A horde of savages, who settle in a valley, where man had never before penetrated, find grains of gold accumulated there for thousands of years; while, in our days, the most careful washing hardly produces a few scattered particles. These considerations, to which I wish to limit myself in this place, may serve to clear up the problem, so frequently agitated, why those regions which immediately after the discovery of America, and especially between 1492 and 1815, were considered as eminently rich in precious metals, furnish scarcely any in our days, although very laborious and well-directed trials have been made in several of them.

To form some idea of the spoil in gold and silver transmitted by the first conquerors to Europe, before the Spaniards began to work the mines of Tasco in Mexico, or Porco in Peru, let us cast our eyes over the facts re-

lated by the historians of the conquest. I have carefully examined these facts, and endeavoured to collect all the passages where the wealth which fell into the hands of the Europeans is estimated in *pesos ensayados*, or in *castellanos de oro*; for it is from these data, and not from the vague, and frequently repeated expressions of "*enormous quantity of gold* or *immense treasures*," that we shall be able to obtain satisfactory results.

In 1502, Ovando sent to Spain a fleet of eighteen vessels, commanded by Bovadilla and Roldan, and laden with a great quantity of gold. The greater part of these vessels perished in the famous tempest in which Christopher Columbus nearly lost his life, in his first voyage, on the shores of St. Domingo. The historians of the time consider this fleet as one of the richest; and yet they all agree that the freight in gold did not exceed 200,000 pesos*, which, reckoning them as *pesos de minas* at 14 reals, make the moderate sum of 1,750,000 livres tournois†, or 2,560 marcs of gold. The presents which Cortez received on his passage through Chalco only amounted to 3000 *pesos de oro*‡, or to 38 marcs of weight in gold.

* *Herrera*, Decada i. Lib. i. Cap. i. (T. i. p. 126.)

† £71,427 Sterling. *Trans.*

‡ *Cartas de Hernan Cortez*, Carta i. § xviii.

When Montezuma assembled his vassals to take the oath of fidelity to the Emperor Charles the Fifth, who, as they were made to believe, descended in a straight line from Quetzalcoatl*, the Bouddha of the Aztecs, Cortez demanded a tribute in gold: "I feigned," he writes to the Emperor, "that your highness was in great "want of this metal for certain works which "you wished to execute." The fifth of the tribute, paid into the chest of the army, amounted to 32,400 pesos†; from which we are to conclude that the quantity of gold collected by the stratagem of the general, amounted to 2080 marcs. At the taking of Tenochtitlan, the spoil which fell into the hands of the Spaniards did not, according to the assertion of Cortez, exceed in weight, 130,000 castellanos, or 2600 marcs of gold‡; and, according to

* See my *Vues des Cordillères*, and *Monumens de l' Amérique*, Pl. vii.

† *Cartas de Hernan Cortez*, Carta i. § xxix. p. 98.

‡ Carta iii. § li. p. 301. The expression *se fundiò mas de* 130,000 *castellanos* is doubtful. We are ignorant whether Cortez speaks of castellanos as a weight, or as an imaginary coin. I follow, with the Abbé Clavigero, the former hypothesis, (*Storia de Messico*, T. iii. p. 232.) In the second case, the spoil would only have been 1660 marcs of gold; for Herrera expressly says, that "*Castellano y peso* "*es uno*," and, according to him, a *peso de minas* is worth 14 reals; a *peso ensayado*, thirteen reals (de plata) and one quartillo. Decada viii. Lib. ii. c. 10. T. v. p. 41.

Bernal Diaz, it amounted to 380,000 pesos, which are equivalent to 4,890 marcs.

The two periods of the conquest of Peru in which the Spaniards collected the greatest quantity of wealth are those of the proceedings against Atahualpa, and the pillage of Cuzco. The ransom of the Inca, which was divided in 1531 among 60 cavaliers and 100 foot, amounted, according to Garcilasso, to 3,930,000 ducats in gold, and 672,670 ducats in silver. Reducing these sums into marcs, we find 41,987 marcs of gold, and 115,508 marcs of silver, amounting together in value to 3,838,058 piastres, at 8 reals *de plata Mexicana*, or 20,149,804* livres tournois.† This treasure, which was collected together in one house, the ruins of which I saw during my stay at Caxamarca in 1802, had served as ornaments in the temples of the sun of Pachacamac, Huailas, Cuzco, Guamachuco, and Sicllapampa. Gomara‡ only estimates the ransom of Atahualpa at 52,000 marcs of silver, and at 1,326,500 *pesos de oro*, or to 17,000 marcs of silver. In whatever relates to numbers, it seldom happens that the

* £822,438 Sterling. *Trans.*

† *Garcilasso*, P. ii. Lib. i. c. 28. and 38. (T. ii. p. 27. and 51.) Father Blas Valera reckons 4,800,000 ducados.

‡ *Historia de las Indias*, 1553, p. 67.

authors of the 16th century are unanimous. The spoil of Cuzco, according to Herrera*, was more than two millions of pesos, or above 25,700 marcs of gold.

From these data, it appears probable that the conquests of Mexico and Peru did not throw into the hands of the Spaniards more than 80,000 marcs of gold. The greater part of the treasures were buried by the Indians, or thrown into the lakes†; and so much of them as has been found from time to time in raking *Huacas*, and paid the fifth to the King, has been confounded with the gold extracted from the mines. If we add to these 80,000 marcs of gold what was carried off in small portions from the West India Islands, the coast of Paria and Saint Martha, Darien and Florida, we shall have, reckoning two thousand marcs per annum till the mines of Tasco and Potosi began to be worked, another sum of 106,000 marcs of gold.

* Dec. v. Lib. vi. c. 3.

† Into the lake of Tezcuco in Mexico; into that of Guatavita, to the north-west of Santa Fe de Bogota; and into those of Titicaca, and of the valley of Orcos. This last lake is supposed to contain the famous gold chain which the Inca Huayna Capac caused to be made on the birth of his son Huescar, and which has so much occupied the imagination of the first colonists of Peru.

The quantity of specie now in circulation in the New World is much less than is commonly supposed. To judge of this with any degree of accuracy, we must recollect that the specie of France * is estimated at 2500 millions of livres tournois†; that of Spain ‡, at 450 millions §; and that of Great Britain ‖, at 920 millions ¶; and that the mass of gold and silver which remains in circulation in a country, far from following a proportion to its population, depends rather on the prosperity and civilization of the inhabitants, and the quantity of productions which require to be represented by pecuniary signs. Supposing the value of the precious metals existing either in specie or in wrought gold and silver:

* According to M. Necker in 1784, at 2200 millions of livres; according to M. Arnould in 1791, two thousand millions of livres; according to M. Desrotours in 1801, at 2290 millions; and according to M. M. Peuchet and Gerboux in 1805, at 2550 millions of livres tournois.

† Upwards of 102 millions Sterling. *Trans.*

‡ According to Ustariz in 1724, a hundred million of piastres, and according to the assertion of M. Musquiz, the minister of finance, cited in the work of Bourgoing, 80 millions of piastres in 1782.

§ £ 18,367,340 Sterling. *Trans.*

‖ Adam Smith only estimates it at 30 millions sterling at most.

¶ £ 37,551,000 Sterling. *Trans.*

	livres tournois.
In the United States, including English Canada - - -	180 millions
In the Spanish Colonies* of the Continent - - - -	480
In Brazil - - - -	120
In the West India Islands - -	25
We find a Total of - -	805 millions†

of livres tournois, or 153,333,000 piastres.

A very small part of the gold and silver extracted from the mines of America passes immediately into Africa and Asia, without first touching Europe. We shall estimate the quantity of precious metals which has passed from Acapulco into the Philippine Islands, since the conclusion of the 16th century, at 600,000 piastres‡ per annum. § The expeditions from

* We have followed, in these valuations, the principles laid down by Adam Smith and Necker, taking for basis the number of inhabitants, the mass of imposts paid to the government, the wealth of the clergy, and the relative activity of commerce. These calculations are the more uncertain, as a great number of Negroes and Indians are mixed with the whites.

† £32,858,137 Sterling. *Trans.*

‡ £126,000 Sterling. *Trans.*

§ I am aware, that Lord Anson found in the Acapulco galleon which fell into his hands, the sum of 1,357,454 piastres (*Anson's Voyage*, p. 384.); but we cannot estimate the annual importation at more than 600,000 piastres, when we consider that the galleon has not sailed every year since the end of the 16th century.

Lima to Manilla have been very rare, even latterly. The vessels sent from the West India Islands, and formerly from the ports of the United States, to the western coast of Africa, in the slave trade, exported not only fire-arms, brandy, and hardwares, but also silver in specie; but this exportation was compensated for by the purchase of gold-dust on the coast of Guinea, and by the lucrative commerce which the Anglo-Americans carry on with several parts of Europe.

Now, if we deduct from the 5706 millions of piastres drawn from the mines of the New Continent, since its discovery by Christopher Columbus till the present day, —

153 millions of piastres, which exist either in specie or in wrought gold and silver in the civilized part of America; and

133 millions of piastres, which have past from the western coast of America into Asia,

286 millions of piastres, —

we find that Europe has received from the New World, in the course of three centuries, 5420 millions of piastres.* Taking, also, the 186,000 marcs of gold which have passed as spoil into the hands of the conquerors at 25 millions,

* £1,138,200,000 Sterling. *Trans.*

it follows that the quantity of gold and silver imported into Europe from America, between 1492 and 1803, amounts to *five thousand four hundred and forty-five millions of piastres*, or to *twenty-eight thousand five hundred and eighty-six millions of livres tournois.* *

This calculation, like all those offered by Forbonnais, Ustariz, Necker, and Raynal, is partly founded on facts and partly on mere conjecture. It is easy to conceive that the results are the more accurate as we were enabled to avail ourselves of a greater number of facts, and as the conjectures are founded on a more intimate acquaintance with the history and present state of the mines of the New Continent. It is for those of my readers who are accustomed to researches of this nature, to judge whether the sums fixed on by me are nearer the truth than those which have been hitherto adopted in the most esteemed and popular works.

Dividing the 5445 millions of piastres among the 311 years since the discovery of the New World till 1803, we find that the average annual importation amounts to seventeen millions and a half of piastres. From the historical researches which it has hitherto been in my power to make, it appears to me that the treasures of America have flowed into Europe in the following progression.

* £1,166,775,322 Sterling.

Periods.	Average annual importation of gold & silver from America into Europe.	Remarks relative to the History of the Mines
	Piastres.	
1492—1500	250,000	Discovery of the West India Islands; Gold stream-works of Cibao; expedition of Alonzo Niño to the coast of Paria; voyage of Cabral. The fleets did not arrive every year in Spain, and that of Ovando was considered as immensely rich, though it was only laden with 2560 marcs of silver.
1500—1545	3,000,000	The Mexican mines of Tasco, Zultepeque, and Pachuca wrought; Peruvian mines of Porco, Carangas, Andacava, Oruro, Carabaya, and Chaquiapu (or la Paz); spoil at Tenochtitlan, and at Caxamarca, and Cuzco; conquest of Choco and Antioquia.
1545—1600	11,000,000	Mines of Zacatecas and Guanaxuato in New Spain; Cerro del Potosi, in the Cordilleras of Peru; tranquil possession of Chili, and the *provincias internas* of Mexico.
1600—1700	16,000,000	The mines of Potosi begin to get exhausted, especially after the middle of the 17th century; but the mines of Yauricocha are discovered. The mining produce of New Spain, rises from two to five millions of piastres per annum; the gold stream-works of Barbacoas and Choco.
1700—1750	22,500,000	The alluvial mines of Brazil wrought; Mexican mines of la Biscaina, Xacal; Tlapujahua, Sombrerete, and Batopilas; importation of gold and silver into Spain, from 1748 to 1753, at an average 18 millions of piastres annually.

Periods.	Average annual importation of gold & silver from America into Europe.	Remarks relative to the History of the Mines.
	Piastres.	
1750—1803	35,300,000	Last period of the splendour of Tasco; mine of Valenciana wrought; discovery of the mines of Catorce, and the Cerro de Gualgayoc; importation of gold and silver into Spain, towards the commencement of the 19th century, 43½ millions of piastres.

We have already remarked that the proportion between gold and silver, which was before the discovery of America as 10 to 1, gradually changed to 16 : 1. It would be of importance to know the quantity of gold which at different periods has flowed from the one continent to the other; but for this we want accurate data. The little which we know is reduced to the following facts:

Till 1525 Europe had received from the new world little else than gold; and from that period till the discovery of the mines of Brazil, towards the end of the seventeenth century, the silver imported exceeded the importation of gold in the proportion of 60 or 65 to 1. In the first half of the eighteenth century, the commerce in the precious metals underwent an extraordinary revolution: the produce of the silver mines experienced small variation; but Brazil, Choco, Antioquia, Popayan and Chili, have furnished so considerable a quantity of gold, that Europe has not perhaps drawn from America 30 marcs of silver for one marc of gold. In the last half of the past century the silver has again increased in the market. The mines of Mexico supplied Spain at an average with two millions and a half of marcs of silver annually, instead of the six hundred thousand which they furnished between 1700 and 1710. As the produce of gold has not continued to increase in the same proportion, the result is, that from 1750 to 1800, the quantity of gold imported into Europe was to the quantity of silver imported* in the proportion of 1 to 40. The mines of New Spain have, as it were, counterbalanced the effects which the abundance of the gold of Brazil would have produced. In general, we ought not to be astonished that the proportion between the respective values of gold and silver has not always varied in a very sensible manner according as one of these may have preponderated in the mass of metal imported from America into Europe. The accumulation of silver appears to have produced its whole effect

* Meggens found the proportion between gold and silver, from 1748 to 1753, as 1 to $22\frac{2}{5}$; from 1753 to 1764, as 1 to $26\frac{4}{13}$. M. Gerboux supposed it in 1803 as 1 to $29\frac{1}{6}$.

anterior to the year 1650, when the proportion of gold and silver was in Spain and Italy as 1 to 15. Since that period the population and commercial relations of Europe have experienced such a considerable increase, that the variations in the value of the precious metals have depended on a great number of combined causes, and especially on the exportation of silver to the East Indies and China, and its consumption in plate.

If Europe at present produces, according to M. Héron de Villefosse, 215,000 marcs of silver for 5300 marcs of gold, or 40 marcs of silver for one marc of gold, it appears, on the other hand, that in the fifteenth and sixteenth centuries, the proportion was more in favour of the silver. The produce of the gold mines and stream-works diminished in Germany and Hungary at the time that the silver mines were most successfully wrought. The mines of Freiberg alone, which, in the sixteenth century, yielded only 16,000 marcs per annum, yield more than 50,000 at present. I am inclined to believe, that, even without the discovery of America, the value of gold would have risen in Europe.

Let us examine, before concluding this chapter, what has become of the treasures drawn from the New Continent. Where are the twenty-eight thousand millions of livres

tournois, which Europe has received for three centuries from Spanish and Portuguese America? Forbonnais supposed, that, of 27½ thousand millions of livres, which, according to him, were imported from the one continent into the other between 1492 and 1724, one half has been absorbed by the Indian and Levant trade; that a fourth was used in plate, or lost in melting, or by the minute division in trinkets; and that the remainder was converted into specie. He estimated the precious metals circulating in Europe in 1766 at 7500 millions of livres tournois *, without including in this sum the produce of the mines of Spanish America since 1724, nor the specie existing in Europe previous to the discovery of the New World. M. Gerboux, in an interesting memoir on pecuniary legislation, has endeavoured to verify and extend the calculations of Forbonnais. He believes the actual existing specie of Europe amounts to 10,600 millions of livres tournois †, or 219 millions of piastres, and that before 1492 there were only 600 millions, or 114 millions of piastres.‡

It is surprising that such an enlightened financier as M. Necker should have ad-

* £306,122,400 Sterling. *Trans.*
† £432,652,992 Sterling. *Trans.*
‡ £24,489,792 Sterling. *Trans.*

vanced, in 1775, that the specie of France constituted nearly the half of the coin of Europe, and that the whole of Europe only possessed 4500 millions of livres tournois *, in specie. The inaccuracy of this assertion has been proved by M. Demeunier, in the *Encyclopédie Méthodique*, and by M. Gerboux and M. Peuchet. † Indeed, M. Necker himself has greatly modified it in his work on the administration of the finances.

On the other hand, the estimate of M. Gerboux, who admits that the actual specie of Europe amounts to ten thousand six hundred millions of livres ‡, appears a great deal too high, when we turn our attention to the population of this part of the world. It is generally believed that the quantity of the precious metals which circulated in ante-revolutionary France, is known with considerable certainty; and on account of the losses occasioned by the pecuniary law (*loi monétaire*) of November 30th, 1785, and the destruction of the colonial commerce, the circulation in 1803 is

* £183,673,440 Sterling. *Trans.*

† *Demeunier, Economie Politique.* t. ii. p. 325. *Gerboux*, p. 75. & 92. *Peuchet, Statistique de la France*, p. 474. *Necker de l'Administration des Finances*, t. iii. p. 75.

‡ £432,652,992 Sterling. *Trans.*

estimated at 1850 millions of livres tournois. * If we estimate for that period, the population at 26,363,000, we find 69 livres for each inhabitant. Now Europe contains, according to the recent researches of Mr. Hassel, 182,600,000 inhabitants, whereof Russia, Sweden, Norway, Denmark, and the Sclavonian and Sarmatian nations, constitute more than 62 millions. Allowing for Great Britain and for the West and South of Europe, 55 livres per individual, and for other countries less advanced in civilization †, 30 livres, we shall find that the total specie of Europe cannot be carried beyond 8603 ‡ millions (1637 millions of piastres) a sum almost equal to the half of the debt of Great Britain. §

* £73,469,376 Sterling. *Trans.*

† In 1805 the effective currency of the Austrian monarchy was estimated at 250 or 300 millions of florins, admitting a population of 25,548,000 inhabitants. (*Hassel Statist. Umriss von Europa*, p. 29.) How could the Abbé Raynal estimate the specie of Portugal at only 18 millions of livres, and that of Brazil at 20 millions? (*Hist. Philos.*, t. ii. p. 434 and 450.) Brazil contains at present four millions of inhabitants, among whom there are 1,500,000 Negroes; and how could he suppose that in a country, where even the Indians enjoy more of the benefits of life than in the Spanish Colonies, and where there are very populous cities, only ten livres per free individual, when in the northern part of Europe, we must reckon from 30 to 40?

‡ £351,142,800 Sterling. *Trans.*

§ *Playfair, Statistical Breviary.* (1801. p. 37.) The debt amounted in 1802 to 562 millions Sterling; in 1810 to 640 millions.

Hence, if the population of France is actually in the proportion of one to five to that of Europe, the quantity of precious metals which it contains is to that which is spread throughout Europe as 1 to 3¼.

We have already seen that the mines of Asiatic Russia, and Europe, annually furnish a produce of 21 millions of livres, or four millions of piastres per annum. * We learn from the Dutch authors, that from four to five thousand marcs of gold come annually in dust from Guinea into Europe. We estimate the produce of the mines of Europe, and the importation from Northern Asia and Africa, since the discovery of America, at only six millions of livres per annum †; and hence, supposing the actual specie of Europe 8603 millions, and, according to M. Gerboux, that which existed in 1492 at 600 millions, it follows that since the end of the 15th century 22,450 millions of livres have been carried out to the East Indies, converted into plate, and lost by melting. Dividing this sum among 213 years, we find at an average, an annual loss in gold and silver of 72 millions of livres ‡ (13,700,000 piastres). It has already been proved that the importation from America during the same period, amounted to 92 millions of livres (17½ millions of piastres) per annum.

* £840,000 Sterling. *Trans.*
† £244,897 Sterling. *Trans.*
‡ £2,938,774 Sterling. *Trans.*

The time is yet so recent since statistical researches first began to be carried on, that it is impossible to know in detail, the value of the exportations of gold and silver into Asia in the sixteenth and seventeenth centuries. We shall merely then take a rapid view of the present state of things, and observe the periodical flux and reflux by which the precious metals are conveyed from one continent to the other. If we recollect that, since the conclusion of the eighteenth century, Europe receives annually from America, nearly 80,000 marcs of gold, and nearly four millions of marcs of silver Castille weight, we must be surprised not to observe more sensible effects from the accumulation of the metals in the old world.

The gold and silver of Europe flow into Asia by three principal ways: 1st. By commerce with the Levant, Egypt, and the Red Sea; 2nd. By maritime commerce with the East Indies and China; and 3rd., By the commerce of Russia with China and Tartary.

The commerce of the Levant and the Northern coast of Africa requires a considerable quantity of ducats, piastres, and German

dollars, the exportation of which diminishes the specie of Europe. We cannot, however, by any means, estimate this loss at more than four millions of piastres per annum *, because the balance of the trade of the Levant is at present in favour of England † to the amount of from two millions and a half to three millions of piastres. According to the tables published by M. Arnould ‡, the trade was in 1789 from three to four millions against France. Spain, the nations of the north, and especially Germany, are obliged to pay in specie in the ports of the Ottoman empire and the Barbary coast. The exportation of silver from the Austrian monarchy alone into Turkey and the Levant is estimated at a million and a half of piastres.

The East Indies and China are the countries which absorb the greatest part of the gold and silver extracted from the mines of America. I cannot admit, that before 1760 this absorption was eight millions of piastres per annum §, and that from that period till

* £840,000 Sterling. *Trans.*

† According to the tables of M. Playfair, Great Britain gained in 1800, in her trade with the Levant, £600,000 Sterling; and she lost in her trade with Turkey, £60,000 Sterling (*Commercial Atlas*) 1801. pl. xiii.

‡ *De la Balance du Commerce*, t. iii. n. ii.

§ £1,680,000 Sterling. *Trans.*

1803, it has gradually diminished to 5 millions. * Although we generally form exaggerated ideas of the loss experienced by Europe in the balance of trade with Asia, it is not the less certain that the exportation of specie greatly exceeds the sum specified by the estimable author whom we have just now quoted.

The luxury of Europe at present, requires eleven times more tea than in 1721; but, on the other hand, the commerce with the countries situated on this side the Ganges, has experienced a very considerable change since the period when the English formed a great empire in India. The manufactories of Great Britain actually furnish to the commerce with southern Asia, goods to the value of more than 11,460,000 piastres per annum. † According to the valuable information contained in the Travels of Lord Macartney ‡, the En-

* *Gerboux*, p. 36. and 70. Consult also the researches of *M. Garnier* respecting the commerce of India, in his Commentary on *Smith*, t. v. p. 361—375, and *Toze*, p. 124—150.

† *Playfair's Chart.* iii.

‡ Macartney's Travels (French Edit.), vol. i. p. 47. and 58. By the table given, page 73. the importation of silver by the English East India Company would only have been, from 1775 to 1795, £3,676,000 Sterling. (I value the pound sterling at $4\frac{423}{1000}$ piastres, or 463 sous tournois). *Author.*

The

glish imported into Canton, in 1725, in the produce of their own manufactories and Indian goods to the value of 4,410,000 piastres. They received in return Chinese goods and produce to the value of 6,614,000 piastres. Supposing the balance of trade with China, to have been more unfavourable for the other nations of Europe, than for the English, we might estimate the importation of the precious metals into China, by Canton, Macao, and Emoui, at an average of 4 or 5 millions of piastres per annum. * In 1766 it still amounted to 2,688,000 piastres only. †

Let us examine more narrowly the state of the trade of Canton. Lord Macartney in 1795 valued the quantity of tea purchased by all the nations of Europe, only at 34 millions of pounds, of which the English alone took 20 millions. But according to the interesting information communicated by M. de Sainte Croix ‡, there was exported from Canton:

The author in a note to page 16. estimates the English shilling at 25 sous: now 20 shillings=£1=500 sous. *Trans.*

* £840,000, or £1,050,000 Sterling. *Trans.*

† *Raynal*, t. i. p. 674.

‡ *Voyage commercial et politique aux Indes Orientales, par M. Félix Renouard de Sainte Croix*, 1810, t. iii. p. 153. 161. and 170. The price of a pic or pickle of bou tea at Canton, is from 12 to 15 taels (at 7 francs 41 cent.

Years.	By all the Nations of Europe, and by the Anglo-Americans.	By the English alone.
In 1804.	411,149 pickles.	279,063 pickles.
1805.	353,480	245,021
1806.	357,506	258,185
Average year.	374,045	260,756
A pickle being 120 pounds, French weight.	44,885,000 lib.	31,290,900lb.

The exportation of tea has then increased, between 1795 and 1806, more than one fourth. Yet we can hardly admit, that the loss of specie annually experienced by Europe increases in the same proportion: for the importation of English woollen stuffs alone into China, rose from 600,000 piastres to 3 millions of piastres, between 1787 and 1796.

According to M. de Guignes, who had the singular good fortune of penetrating into the interior of China, the quantity of specie imported into Canton by the English, did not amount in 1807, to more than 3 millions of piastres. If Great Britain did not possess a

the tael). Other sorts of tea are much dearer; the cang-fou costs from 25 to 27 taels; the saoutchou costs from 40 to 50; the haysuen from 50 to 60 (*Des Guignes, Voyage à Pékin*, t. iii. p. 248. *Ephémérides Geogr. de M. de Zach*, 1798, p. 179—191.)

considerable part of the East Indies, her loss in specie would be more than doubled; for nearly 4 millions of piastres are annually paid to the Chinese by the commerce from one part of India to another, that is to say, by the cotton of Surat and Bombay, by the tin (*calin*) of Malacca, and by the opium of Bengal. The Dutch paid their balance with 1,300,000 piastres, the Swedes and the Danes together, with a million.* France, from 1784 to 1808, lost, in general, in her commerce with the East Indies, at an average, 6,968,000 livres tournois, or 1,327,000† piastres. These partial data agree very well with the general result which we fixed on above, for the exportation of silver into China.

It is more difficult to estimate the loss experienced by Europe in her relations with the whole of Asia, from the commerce by the Cape of Good Hope. That part of the loss applicable to the commerce of the English, was, in 1800, according to the researches of Mr. Playfair‡, £2,200,000 Sterling, or 9,701,000 piastres. It is true that the same author estimates the value of the exports from all Hindostan, at 30 millions of piastres; but

* *De Guignes*, iii. p. 206, 207. 210. 215.

† *Arnould de la Balance du Commerce*, t. iii. N°. 13.

‡ *Trade to and from the East Indies*. (Atlas pl. iii. p. 13.)

this vast country not only gains in its commerce with Europe, but also in its commerce with the other parts of Western Asia, and the islands in its vicinity. While we acknowledge the great uncertainty of these calculations of balance, and national accounts, we are forced to recur to them to obtain results which approach the truth. It appears from the information just given, that the exportation of gold and silver from Europe, by the way of the Cape of Good Hope, amounts to more than 17 millions of piastres. In this calculation we have attended to the present state of the trade of Madagascar, Mokka, and Bassora, as well as the auriferous copper of Japan, supplied by the Dutch trade to Nagasaki*, and the treasures which the servants of the East India Company bring from Bengal into England. These treasures were valued by Mr. Dundas at more than 4 millions of piastres per annum.

If a part of China should have the misfortune of being subjugated by some warlike nation, which was at once mistress of Mexico, Peru, and the Philippine islands, this conquest would occasion a smaller reflux of the precious metals into America or Europe, than we are generally inclined to believe. We

* *Thunburg, Voyage au Japon*, t. ii. p. 8.

see from the accounts of Macartney, Barrow, De Guignes, and other intelligent travellers, that gold and silver are not more common in China, than in the greatest part of the countries of Europe. The annual revenue of the state, is no doubt estimated at 1584 millions of francs * (301,714,000 piastres †; but the greater part of this sum is paid in the produce of the soil and Chinese industry; and according to M. Barrow ‡, the quantity which enters Pekin in specie annually, only amounts to 36 millions of ounces of silver, which are estimated at 52,914,000 piastres. The Chinese believe that large sums are annually sent to Moukden, the capital of the country of the Mantchou Tartars; but this opinion is not founded on facts. Several mandarins are in the possession of immense wealth. The prime minister of the Emperor Tchienlong, was stript of 10 millions of taels, or 74,500,000 livres tournois § in specie, which he had accumulated by extortion ‖; but the emperor is very frequently

* £64,653,000 Sterling. *Trans.*

† According to Lord Macartney; 710 millions according to M. De Guisnes. t. iii. p. 102.

‡ Barrow's Travels (French Edit.) t. ii. p. 198.

§ £3,040,815 Sterling. *Trans.*

‖ *Barrow*, t. ii. p. 173.

in want of money. What Europe loses in the balance of trade with China, is spread over a great population; a considerable quantity of gold and silver is converted into wire and plates *; the accumulation of specie is very slow, and has scarcely begun to be felt within these twenty years, in an increase of the price of commodities. †

There remains to be considered a third way for the exportation of the precious metals from Europe into Asia, that which is carried by the Russian trade. We learn by the tables published by the Count de Romanzof, that the importation from China, into the government of Irkoutsk, was, from 1802 to 1805, at an average, to the amount of 2,035,900 roubles in tea, and 2,434,400 in cotton. In general, the balance of trade of Russia with China, Bucharia, the country of Khiva, and the banks of the Kirghiskaisaks, was in favour of the Russian Empire, during the same period, more than 4,216,000 roubles per annum. ‡ We see from these data, that in estimating the contraband at a sixth, the exportation of specie, by

* *Macartney*, vol. iv. p. 286.

† *Macartney*, vol. iii. p. 105.; vol. iv. p. 231.

‡ *Tableau du Commerce de l'Empire de Russie*, translated by M. Pfeiffer, 1808, Nos. 9 and 10. *Olivarius le Nord Litteraire*, 1799, No. 7. p. 202.

means of the Caspian sea, Caucasus, Orenburg, Tobolsk, Tomsk, Irkoutsk, and Kiachta, cannot amount to more than 4 millions of piastres.

We have ascertained then *, from sources which must be considered as the best, that of the

43,500,000 piastres which Europe at present receives annually from America, there flow nearly

25,500,000 {
- 4,000,000, into Asia, by means of the Levant trade;
- 17,500,000, into Asia by the Cape of Good Hope;
- 4,000,000, into Asia, by the way of Kiachta and Tobolsk;

18,000,000 gold and silver of America, which remain in Europe.

We must deduct from these eighteen millions of piastres, or 94,500,000 livres tournois †, what is lost by melting down, and dissipated in a number of small jewels and trinkets, as well as what is used in plate, lace, and gilding. It was ascertained at the mint of Paris, that from 1709 to 1759, the increase of plate was in the proportion of 1 to 7. M. Necker thought himself warranted in estimating previous to 1789, at 4 millions of piastres *, the amount annually consumed in jewels, lace, and embroidered stuffs manufactured in France. † Part of these metals was evidently derived from melting down the old plate and lace; however the annual consumption by the goldsmiths of ingots of silver, is very considerable ‡; and when we add what disappears, from transportation, and the friction of daily circulation, we may estimate, with Forbonnais, and other writers on political economy, that the quantity of precious metals which disappear in Europe, or which are converted into plate and lace, amounts to a third of the total mass which is not consumed by the commerce with Asia, that is at six or seven millions of piastres per annum. On the other hand, the mines of Europe and Siberia furnish annually nearly 4 millions of piastres. According to these calculations, which from their nature can only be approximate, the increase of the gold and silver currency of Europe appears only to be fifteen millions of piastres, or 78,700,000 livres tournois. § Those

* See the sketch of a map, exhibiting the flux and reflux of the precious metals from one continent to the other, in the atlas to this work.

† £3,780,000 Sterling. *Trans.*

* £840,000 Sterling. *Trans.*

† *Necker*, t. iii. p. 74. *Peuchet*, p, 429.

‡ *Smith*, t. ii. p. 60 & 73.

§ £3,212,243 Sterling. *Trans.*

persons who have long inhabited the north and east of Europe, and attentively followed the progress of civilization among the lowest classes of the people in Poland, Norway, and Russia, will entertain no doubt of the reality of this accumulation of specie. Its effects must be scarcely perceptible, because the capital of all Europe is only increased at the rate of one per cent. per annum.

The view which we have exhibited in this chapter, of the present state of the mines of the New World, and of those of Mexico in particular, ought to lead us to entertain a dread of the rapid increase of the sum of representative signs, when the Highlanders of North and South America, shall gradually rouse from their profound lethargy, in which they have so long been plunged. It would be remote from the principal object of this work, to discuss whether the interests of society would really suffer from this accumulation of specie. It is sufficient in this place to observe, that the danger is not so great as it appears on a first view, because the quantity of commodities which enter into commerce, and which require to be represented, increases with the number of representative signs. The price of grain, it is true, has tripled since the treasures of the New Continent were poured into the Old. This

rise, which was not felt till the middle of the 16th century, took place suddenly between 1570 and 1595, when the silver of Potosi, Porco, Tasco, Zacatecas, and Pachuca, began to flow throughout all parts of Europe. But, on the other hand, between that memorable period in the history of commerce, till 1636, the discovery of the mines of America produced its whole effect on the reduction of the value of money. The price of grain has not in reality risen to the present day; and if the contrary has been advanced by several authors, it is from their having confounded the nominal value of coin, with the true proportion between money and commodities.

Whatever opinion may be adopted as to the future effects of the accumulation of the representative signs, if we consider the people of New Spain under the relation of their commercial connections with Europe, it cannot be denied that, in the present state of things, the abundance of the precious metals has a powerful influence on the national prosperity. It is from this abundance, that America is enabled to pay in specie, the produce of foreign industry, and to share in the enjoyments of the most civilized nations of the Old Continent. Notwithstanding this real advantage, it is to be sincerely wished, that the Mexicans, enlightened as to their true interest, may re-

collect that the only capital of which the value increases with time, consists in the produce of agriculture, and that nominal wealth becomes illusory, whenever a nation does not possess those raw materials, which serve for the subsistence of man, or as employment for his industry.

BOOK V.

STATE OF THE MANUFACTURES AND COMMERCE OF NEW SPAIN.

CHAPTER XII.

Manufacturing Industry — Cotton Cloth — Woollen — Cegars — Soda and Soap — Powder — Coin — Exchange of Productions — Internal Commerce — Roads — Foreign Commerce by Vera Cruz and Acapulco — Obstacles to that Commerce — Yellow Fever.

If we consider the small progress of manufactures in Spain, notwithstanding the numerous encouragements which they have received, since the ministry of the Marquis de la Ensenada, we shall not be surprised that whatever relates to manufactures and manufacturing industry is still less advanced in Mexico. The restless and suspicious policy of the nations of Europe, the legislation and colonial policy of the moderns, which bear very little resemblance to those of the Phenicians and Greeks, have thrown insurmountable obstacles in the way of such settlements

as might secure to these distant possessions, a great degree of prosperity, and an existence independent of the mother country. Such principles as prescribe the rooting up the vine and the olive, are not calculated to favour manufactures. A colony has for ages been only considered as useful to the parent state, in so far as it supplied a great number of raw materials, and consumed a number of the commodities carried there by the ships of the mother country.

It was easy for different commercial nations to adapt their colonial system to islands of small extent, or factories established on the coast of a continent. The inhabitants of Barbadoes, St. Thomas, or Jamaica, are not sufficiently numerous to possess a great number of hands for the manufacture of cotton cloth; and the position of these islands at all times facilitates the exchange of their agricultural produce, for the manufactures of Europe.

It is not so with the continental possessions of Spain in the two Americas. Mexico, beyond the 28° of north latitude, contains a breadth of 350 leagues. The table land of New Grenada communicates with the port of Carthagena by means of a great river, difficult to ascend. Industry is awakened, when towns

of fifty and sixty thousand inhabitants are situated on the ridge of mountains at a great distance from the coast; when a population of several millions can only receive European goods, by transporting them on the backs of mules for the space of five or six months, through forests and deserts. The new colonies were not established among people altogether barbarians. Before the arrival of the Spaniards, the Indians were already clothed in the Cordilleras of Mexico, Peru, and Quito. Men who knew the process of weaving cotton, or spinning the wool of the Llamas and Vicunas, were easily taught to manufacture cloth; and this manufacture was established at Cuzco in Peru, and Texcuco in Mexico, a few years after the conquest of those countries, on the introduction of European sheep into America.

The kings of Spain, by taking the title of kings of the Indies, have considered these distant possessions rather as integral parts of their monarchy, as provinces dependent on the crown of Castille, than as colonies in the sense attached to this word since the sixteenth century, by the commercial nations of Europe. They early perceived that these vast countries, of which the coast is less inhabited than the interior, could not be governed like islands scattered in the Atlantic Ocean; and from these circumstances the court of Madrid was

compelled to have recourse to a less prohibitory system, and to tolerate what it was unable to prevent. Hence a more equitable legislation has been adopted in that country than that by which the greatest part of the other colonies of the New Continent is governed. In the latter, for example, it is not permitted to refine raw sugar; and the proprietor of a plantation is obliged to purchase the produce of his own soil from the manufacturer of the mother country. No law prohibits the refining of sugar in the possessions of Spanish America. If the government does not encourage manufactures, and if it even employs indirect means to prevent the establishment of those of silk, paper, and crystal; on the other hand, no decree of the *audience*, no royal *cedula*, declares that these manufactures ought not to exist beyond sea. In the colonies, as well as every where else, we must not confound the spirit of the laws with the policy of those by whom they are administered.

Only half a century ago, two citizens, animated with the purest patriotic zeal, the Count de Gijon, and the Marquis de Maenza, conceived the project of bringing over to Quito, a colony of workmen and artizans from Europe. The Spanish ministry affected to applaud their zeal, and did not think proper to refuse them the privilege of establishing

manufactories; but they so contrived to fetter the proceedings of these two enterprising men, that they at last perceived that secret orders had been given to the viceroy and the *audience* to ruin their undertaking, which they voluntarily renounced. I could wish to believe that such an event would not have taken place at the period when I resided in these countries; for it is not to be denied that, within these twenty years, the Spanish Colonies have been governed on more enlightened principles. Virtuous men have from time to time raised their voice to enlighten the government as to its true interest; and they have endeavoured to impress the mother country with the idea, that it would be more useful to encourage the manufacturing industry of the Colonies, than to allow the treasures of Peru and Mexico to be spent in the purchase of foreign commodities. These counsels would have been attended to, if the ministry had not too frequently sacrificed the interests of the nations of a great continent, to the interest of a few maritime towns of Spain; for the progress of manufactures in the Colonies has not been impeded by the manufacturers of the peninsula, a quiet and laborious class of men, but by trading monopolists, whose political influence is favoured by great wealth, and kept up by

a thorough knowledge of intrigue, and the momentary wants of the court.

Notwithstanding all these obstacles the manufactures have not been prevented from making some progress in three centuries, during which time, Biscayans, Catalonians, Asturians, and Valencians have settled in the New World, and carried there the industry of their native provinces. The manufactures of coarse stuffs can every where be carried on at a low rate, when raw materials are found in abundance, and when the price of the goods of Europe and Oriental Asia is so much increased by carriage. In time of war, the want of communication with the mother country, and the regulations prohibiting commerce with neutrals, have favoured the establishment of manufactures of calicoes, fine cloth, and whatever is connected with the refinements of luxury.

The value of the produce of the manufacturing industry of New Spain is estimated at seven or eight millions of piastres per annum.* In the Intendancy of Guadalaxara, cotton and wool were exported till 1765, to maintain the activity of the manufactures of Puebla, Queretaro, and San Miguel el Grande. Since that period, manufactories have been established at Guadalaxara, Lagos, and the

* £1,470,000, or £1,680,000 Sterling. *Trans.*

neighbouring towns. The whole intendancy, which contains more than 630,000 inhabitants, and of which the coast is washed by the South Sea, supplied in 1802*, cotton and woollen manufactures to the value of 1,601,200 piastres; tanned hides to the value of 418,900 piastres; and soap to the amount of 268,400 piastres.

We have already proved, speaking of the different varieties of *gossypium*, cultivated in the warm and temperate regions, the importance of native manufactures of cotton for Mexico. Those of the intendancy of Puebla furnish annually in time of peace, for the interior commerce, a produce to the value of 1,500,000 piastres. However, this produce is not derived from considerable manufactures, but from a great number of looms, (*telares de algodon*) dispersed throughout the towns of Puebla de los Angeles, Cholula, Huexocingo, and Tlascala. At Queretaro, a considerable town situated on the road from Mexico to Guanaxuato, there is annually consumed 200,000 pounds of cotton, in the manufacture of *mantas* and *rebozos*. The manufacture of *mantas*, or cotton, amounts annually to 20,000 pieces of 32 varas each. The weavers of cottons of

* *Estado de la intendencia de Guadalaxara, communicado en* 1802 *por el Senor intendente al Consulado de Vera Cruz.* (Official manuscript paper.)

all sorts in Puebla were computed in 1802 at more than 1200.* In this town, as well as in Mexico, the printing of calicoes, both those imported from Manilla, and those manufactured in New Spain, has made considerable progress within these few years. At the port of Tehuantepec, in the province of Oaxaca, the Indians dye the unwrought cotton by rubbing it against the cloak of a *murex*, which is found attached to the granite rocks. From an old custom, they wash the cotton in sea water, which in their parallels is very rich in muriate of soda, to give it a bright colour.

The oldest cloth manufactories of Mexico are those of Tezcuco. They were in great part established in 1592 by the viceroy Don Louis de Velasco II., the son of the celebrated constable of Castille, who was second viceroy of New Spain. By degrees, this branch of national industry passed entirely into the hands of the Indians and Mestizoes of Queretaro and Puebla. I visited the manufactories of Queretaro in the month of August 1803. They distinguish there the great manufactories, which they call *obrajes*, from the small, which go by the name of *trapiches*. There were

* *Informe del intendente Don Manuel de Flon conde de la Cadena.* (M.S.)

20 *obrajes*, and more than 300 *trapiches* at that time, who altogether wrought up 63,900 arrobas of Mexican sheep-wool. According to accurate lists, drawn up in 1793, there were at that period at Queretaro, in the *obrajes* alone, 215 looms, and 1500 workmen who manufactured 6042 pieces, or 226,522 varas of cloth (*paños*): 287 pieces, or 39,718 varas of ordinary woollens (*xerguatillas*); 207 pieces, or 15,369 varas of baize (*bayetas*); and 161 pieces, or 17,960 varas of serge (*xergas*). In this manufacture they consumed 46,270 arrobas of wool, the price of which only amounted to 161,945 piastres. They reckon in general seven arrobas of wool to one piece of cloth and *bayeta;* six arrobas to one piece of *xerguatilla*, and five arrobas to one piece of *xerga*. The value of the cloths and woollen stuffs of the *obrajes* and *trapiches* of Queretaro at present amounts to more than 600,000 piastres, or three millions of francs per annum. *

On visiting these workshops, a traveller is disagreeably struck, not only with the great imperfection of the technical process in the preparation for dyeing, but in a particular manner also with the unhealthiness of the situation, and the bad treatment to which the workmen are exposed. Free men, Indians, and people of colour, are confounded with the criminals

* £122,448 Sterling. *Trans.*

distributed by justice among the manufactories, in order to be compelled to work. All appear half naked, covered with rags, meagre, and deformed. Every workshop resembles a dark prison. The doors, which are double, remain constantly shut, and the workmen are not permitted to quit the house. Those who are married, are only allowed to see their families on Sundays. All are unmercifully flogged, if they commit the smallest trespass on the order established in the manufactory.

We have difficulty in conceiving how the proprietors of the *obrajes* can act in this manner with free men, as well as how the Indian workman can submit to the same treatment with the galley slaves. These pretended rights are in reality acquired by stratagem. The manufacturers of Queretaro employ the same trick, which is made use of in several of the cloth manufactories of Quito, and in the plantations, where from a want of slaves, labourers are extremely rare. They choose from among the Indians the most miserable, but such as show an aptitude for the work, and they advance them a small sum of money. The Indian, who loves to get intoxicated, spends it in a few days, and having become the debtor of the master, he is shut up in the workshop, under the pretence of paying off the debt by the work of his hands. They allow him only a

real and a half, or 20 sous tournois per day of wages; but in place of paying it in ready money, they take care to supply him with meat, brandy, and clothes, on which the manufacturer gains from fifty to sixty per cent.; and in this way the most industrious workman remains for ever in debt, and the same rights are exercised on him, which are believed to be acquired over a purchased slave. I knew many persons at Queretaro, who lamented with me the existence of these enormous abuses. Let us hope that a government friendly to the people, will turn their attention to a species of oppression so contrary to humanity, the laws of the country, and the progress of Mexican industry.

With the exception of a few stuffs of cotton mixed with silk, the manufacture of silks is at present next to nothing in Mexico. In the time of Acosta, towards the conclusion of the sixteenth century, silk worms brought from Europe where cultivated near Panuco, and in la Misteca, and excellent taffeta* was there manufactured with Mexican silk. We have already observed that it was not the *bombyx-mori*, but an indigenous caterpillar which supplied the raw materials, for the silk handker-

* *Acosta*, lib. iv. c. 32, p. 179. — See also Chap. x. p. 57. of this volume.

chiefs manufactured by the Indians of Misteca, and the village of Tistla near Chilpansingo.

New Spain has no flax or hemp manufactories; and the manufacture of paper is also unknown in it. The manufacture of tobacco is a royal right. The expence of the manufacture of cegars and snuff, annually amounts to more than 6,200,000 livres tournois*. The manufactures of Mexico and Queretaro are the most considerable. The following is an account of the whole manufacture during the years 1801 and 1802.

Tobacco manufactured in New Spain.	In 1801. Piastres.	In 1802. Piastres.
Value of Tobacco manufactured agreeably to sales - - -	7,825,913	7,686,834
Expence of manufacture - -	1,299,411	1,285,199
Salaries of Officers - - - -	798,452	794,586
Price of Tobacco purchased from the Mexican husbandmen -	626,319	594,229
Net Revenue (*liquido*) of the Crown, on the sale of Tobacco	3,993,834	4,092,629

On my passage through Queretaro, I visited the great manufactory of cegars (*fabrica de*

* 253,060*l.* sterling. *Trans.*

puros y cigarros), in which 3000 people, including 1900 women, are employed. The halls are very neat, but badly aired, very small, and consequently excessively warm. They consume daily in this manufacture 130 reams (*resmas*) of paper, and 2770 pounds of tobacco leaf. In the course of the month of July, 1803, there was manufactured to the amount of 185,288 piastres; viz. 2,654,820 small chests (*caxillas*) of cegars, which sell for 165,926 piastres, and 289,799 chests of *puros* or cegars, which are not enveloped in paper. The expence of manufacture of the month of July alone, amounted to 31,789 piastres. It appears that the royal manufactory of Queretaro annually produces more than 2,200,000 piastres, in *puros* and cigarros.

The manufacture of hard soap is a considerable object of commerce at Puebla, Mexico, and Guadalaxara. The first of these towns produces nearly 200,000 arrobas per annum; and in the intendancy of Guadalaxara, the quantity manufactured is computed at 1,300,000 livres tournois. The abundance of soda which we find almost every where at elevations of 2000 or 2500 metres*; in the interior table land of Mexico, is highly favourable to this manufacture. The *tequesquite* of which we

* At 6561 or 8201 feet. *Trans.*

have several times had occasion to speak*, covers the surface of the soil, especially in the month of October, in the valley of Mexico, on the banks of the lakes of Tezcuco, Zumpango, and San Christobal; in the plains which surround the city of Puebla; in those which extend from Zelaya to Guadalaxara; in the valley of San Francisco, near San Luis Potosi, between Durango and Chihuagua, and in the nine lakes which are scattered over the intendancy of Zacatecas. We know not whether it derives its origin from the decomposition of volcanic rocks in which it is contained, or to the slow action of lime on the muriate of soda. At Mexico, 1500 arrobas of *tierra tequesquitosa*, that is to say an earth impregnated with much carbonate, and a little of the muriate of soda, may be purchased for 62 piastres. These 1500 arrobas purified in the soap manufactories, furnish 500 arrobas of carbonate of pure soda. Hence the quintal, in the present state of the manufacture, comes to 50 sous tournois. M. Garces, who successfully employs carbonate of soda, in the smelting of muriates of silver, has proved in a particular memoir, that in improving the technical process, they could supply in the soda

* See vol. ii. p. 170; and *Del Rio, Elementos de Orycto-gnosia*, p. 154.

manufactories of Mexico called *tequesquiteras*, the carbonate of soda at less than 30 sous tournois the quintal. The price of the carbonates of soda of Spain, being generally in France during peace at 20 and 25 livres the quintal, it is imagined, that notwithstanding the difficulties of carriage, Europe will one day draw soda from Mexico, as she has long drawn potash from the United States of North America.

The town of Puebla was formerly celebrated for its fine manufactories of delf ware, (*loza*) and hats. We have already observed that, till the commencement of the eighteenth century, these two branches of industry enlivened the commerce between Acapulco and Peru. At present there is little or no communication between Puebla and Lima, and the delf manufactories have fallen so much off, on account of the low price of the stone ware and porcelain of Europe imported at Vera Cruz, that of 46 manufactories which were still existing in 1793, there were in 1802 only sixteen remaining of delf ware, and two of glass.

In New Spain, as well as in the greatest number of countries in Europe, the manufacture of powder is a royal monopoly. To form an idea of the enormous quantity of powder manufactured and sold in contraband, we have

only to bear in mind, that notwithstanding the flourishing state of the Mexican mines, the king has never sold to the miners more than three or four thousand quintals of powder per annum*; while a single mine, that of Valenciana, requires from 15 to 16 hundred. It appears from the researches made by me, that the quantity of powder manufactured at the expence of the king, is to that sold fraudulently in the proportion of 1 to 4. As in the interior of New Spain, the nitrate of potash and sulphur are every where to be had in abundance, and the contraband manufacturer can afford to sell powder to the miner at 18 sous tournois the pound, the government ought either to diminish the price of the produce of the manufactory, or throw the trade in powder entirely open. How is it possible to prevent fraud in a country of an immense extent, in mines at a distance from towns, and dispersed on the ridge of the Cordilleras, in the midst of the wildest and most solitary situations?

The royal manufactory of powder, the only one in Mexico, is situated near Santa Fe, in the valley of Mexico, about three leagues from the capital, surrounded with hills of argillous brescia, which contain fragments of trap por-

* In 1801, only 255,455 lb.; in 1802, 339,921 lb. — See p. 201 and 204 of this volume.

phyry. The buildings, which are very beautiful, were constructed in 1780 from the plans of M. Costanzo, the head of the corps of engineers, in a narrow valley which supplies in abundance the necessary water for setting hydraulical wheels in motion, and through which the aqueduct of Santa Fe passes. All the parts of the machines, and chiefly the wheels, are disposed with great intelligence. It is to be wished, however, that the sieves necessary to make the *grain*, were either moved by water or by horses. Eighty mestizo boys, paid at the rate of 26 sous per day, are employed in this work. The buildings of the old powder manufactory, established near the castle of Chapultepec, are only used at present to refine nitrate of potash. Sulphur, which abounds in the volcanoes of Orizaba and Puebla, in the province of San Luis near Colima, and especially in the intendancy of Guadalaxara, where the rivers bring down considerable masses of it, mixed with fragments of pumice stone, comes quite purified from the town of San Luis Potosi. There was made, in the royal powder manufactory of Santa Fe in 1801, more than 786,000 pounds, of which part is exported for the Havannah. It is to be regretted that this fine edifice, where in general more than half a million of pounds of powder is preserved, is not provided with an electrical

conductor. During my stay in New Spain, there were only two conductors in that vast country, which were constructed at La Puebla by orders of an enlightened administrator, the Count de la Cadena, notwithstanding the imprecations of the Indians, and a parcel of ignorant monks.

While mentioning the powder manufactory of Santa Fe, I ought not to pass under silence a historical fact which is repeated in several works, although it rests on no very solid foundation. It is said that the valiant Diego Ordaz penetrated the crater of the volcano of Popocatepetl, for the purpose of procuring sulphur, and by that means enabled the Spaniards to manufacture the powder which was required for the siege of the city of Mexico. The falsity of this assertion is proved by the very letters, which the general in chief addressed to the Emperor Charles the Fifth. When the united army of Spaniards and Tlascaltecs, in the month of October, 1519, marched from Cholula to Tenochtitlan, it crossed the Cordillera of Ahualco, which unites the Sierra Nevada, or the Iztaccihuatl, to the volcanic summit of Popocatipetl. The Spaniards followed nearly the same track, which the courier of Mexico takes in his way to Puebla, by Mecameca, which is traced on the map of the valley of Tenochtitlan. The army suffered

both from the cold, and the extreme impetuosity of the winds, which constantly prevail on this table land. Cortez, speaking of this march to the Emperor, expresses himself in the following manner*: "Seeing smoke issue from a very elevated "mountain, and wishing to make to your royal "excellency a minute report of whatever this "country contains of wonderful, I chose from "among my companions in arms, ten of the "most courageous, and I ordered them to as-"cend the summit, and to discover the secret "of the smoke (*el secreto de aquel humo*), and "to tell me how and whence it issued."

Bernal Diaz affirms, that Diego Ordaz was of that expedition, and that that Captain attained the very brink of the crater. He may have happened to boast of it afterwards, for it is related by other historians, that the Emperor gave him permission to place a volcano in his arms. Lopez de Gomara†, who composed his history from the accounts of the conquistadores and religious missionaries, does not name Ordaz as the chief of the expedition; but he vaguely asserts that two Spaniards measured with the eye the size of the crater. However Cortez expressly says, "that his people "ascended very high; that they saw much smoke

* *Lorenzana*, p. 70. *Clavigero*, t. iii. p. 68.

† *Gomara*, *Conquista de Mexico*, (Medina del Campo, 553), fol. 38.

"issue out; but that none of them could reach "the summit of the volcano, on account of "the enormous quantity of snow with which "it was covered, the rigour of the cold, and "the clouds of ashes which enveloped the "travellers." A horrible noise which they heard on approaching the summit determined them immediately to turn back. We see from the account of Cortez, that the expedition of Ordaz had no view of extracting sulphur from the volcano, and that neither he nor his companions saw the crater in 1519. "They brought "back," says Cortez, "only snow and pieces of "ice, the appearance of which astonished us very "much, because this country is under the 20° "of latitude, in the parallel of the island *Es-*"*pañola* (Saint Domingo), and consequently "according to the opinion of the pilots ought "to be very warm."

We see from the third and fourth letter of Cortez to the Emperor, that that general, after the taking of Mexico, ordered other attempts to be made for the discovery of the summit of the volcano, which appeared the more to fix his attention, as the natives assured him *that no mortal was permitted to approach that situation of bad spirits.* After two unsuccessful attempts, the Spaniards at length succeeded in 1522, in seeing the crater of the Popocatepetl. It appeared to them three-fourths of

a league in circumference, and they found on the brink of the precipice, a small quantity of sulphur, which had been deposited there by the vapours. Speaking of the tin of Tasco, which was used in founding the first cannon, Cortez* relates, "that he is in no want of "sulphur for the manufacture of powder, be-"cause a Spaniard drew some from a moun-"tain which perpetually smokes, by descending, "tied to a rope, to the depth of from 70 to "80 fathoms." He adds, that this manner of procuring sulphur was very dangerous, and on that account it would be better to procure it from Seville.

A document preserved in the family of the Montaños, and which Cardinal Lorenzana affirms he once had in his hands, proves that the Spaniard of whom Cortez speaks, was named Francisco Montaño. Did that intrepid man really enter into the crater itself of the Popocatepetl, or did he extract the sulphur, as several persons in Mexico suppose, from a lateral crevice of the volcano? We shall discuss this question in another work, when giving the geological description of New Spain. M. Alzate†

* *De alli (de la sierra que da humo), entrando un Español setenta y ochenta brazas, aiado a la bocca abajo, se ha sacado (el azufre), que hasta ahora nos hemos sustenido,* (*Loranzana,* p. 380.)

† *Gazeta de Literatura de Mexico,* 1789, p. 52.

with very little foundation affirms that Diego Ordaz, extracted sulphur from the crater of the old volcano of Tuctli, to the east of the lake of Chalco, near the Indian village of Tuliahualco. The makers of contraband powder no doubt procure sulphur there; but Cortez expressly designates the Popocatepetl by the phrase "the "mountain which constantly smokes." However this matter be, it is certain that after the rebuilding of the city of Tenochtitlan, and not during the siege, as Solis affirms*, the soldiers of the army of Cortez ascended the summit of the Popocatepetl†, where nobody has since been. Had Condamine‡ known the absolute elevation of this volcano, which I found to be 5400 metres §, he would not have believed himself the first who ascended the ridge of the Cordilleras, to the height of 4800 metres ‖ above the level of the ocean. The expeditions of Ordaz and Montaño, naturally lead us to mention the intrepidity of Blas de Iñena a Dominican monk, who in an osier basket provided with a spoon and an iron bucket, was let down by a chain to the depth of 140 fa-

* *Solis, Conquista de Mexico*, p. 142.

† *Lorenzana*, p. 318.

‡ *Bouguer, mesure de la terre*, p. 167. *La Condamine, Voyage*, p. 58.

§ 17,716 feet. *Trans.*

‖ 15,747 feet. *Trans.*

thoms, in the crater of the volcano of Grenada called the Cerro de Messaya, situated near the lake of Nicaragua, for the purpose of extracting the lava which he believed to be gold. He lost his iron bucket, which was melted with the excessive heat, and he had no small difficulty in saving himself. In 1551, Juan Alvarez, dean of the chapter of the town of Leon, obtained formal permission* from the court of Madrid, "to open the volcano, and collect "the gold which it contains." It must be allowed that no physical traveller from a zeal for science has engaged in our days in such hazardous enterprizes as those which were attempted in the beginning of the sixteenth century for the purpose of extracting sulphur or gold from the mouth of flaming volcanoes.

We shall conclude the article of the manufactures of New Spain with mentioning the working of gold and the coining of money, which considered merely in the relation of industry, and mechanical improvement, are objects every way worthy of attention. There are few countries in which a more considerable number of large pieces of wrought plate, vases, and church ornaments are annually executed than in Mexico. The smallest towns have gold and silver smiths, in whose shops workmen of

* *Gomara, Historia de las Indias*, fol. 112.

all casts, whites, mestizoes and Indians are employed. The academy of fine arts, and the schools for drawing in Mexico and Xalapa have very much contributed to diffuse a taste for beautiful antique forms. Services of plate to the value of a hundred and fifty, or two hundred thousand francs, have been lately manufactured at Mexico, which for elegance and fine workmanship may rival the finest work of the kind ever executed in the most civilized parts of Europe. The quantity of precious metals which between 1798 and 1802 was converted into plate at Mexico, amounted at an average to 385 marcs of gold and 26,803 marcs of silver per annum. * The wrought plate of which the fifth is exacted, was declared at the mint as follows:

Years.	Gold Marcs.	Silver Marcs.
1798	402	19,823
1799	484	26,762
1800	412	30,887
1801	379	30,860
1802	249	25,692
Total	1,926	134,024

* Castille weight. It may be useful to observe, that, wherever the contrary is not expressly indicated, the word marc in this work means the *marc of Castille*.

The mint of Mexico, which is the largest and richest in the whole world, is a building of a very simple architecture, belonging to the palace of the viceroys. This establishment, under the direction of the Marquis de San Roman, * an enlightened administrator, and a friend to the arts, contains little or nothing remarkable with respect to the improvement of the machinery or chemical processes; but it well deserves to engage the attention of travellers from the order, activity, and economy which prevail in all the operations of coining. This interest is enhanced by other considerations which are even obvious to those who do not turn their attention to speculations of political administration. In fact it is impossible to go over this small building without recollecting that more than ten thousand millions of livres tournois † has issued from it in less than three hundred years, and without reflecting on the powerful influence of these treasures on the destinies of the nations of Europe.

The mint of Mexico was established fourteen years after the destruction of old Tenochtitlan, under the first viceroy of New Spain, Antonio de Mendoza, by a royal *cedula* of the

* *Vez Superintendente de la real casa de moneda.*

† Upwards of 408,000,000*l.* sterling. *Trans.*

11th May 1535. The coinage was at first carried on by contract by several individuals, to whom the government had farmed it out. Their lease was not renewed in 1733. Since that period all the works are under the direction of government officers on the government account. The number of workmen employed in this mint amounts to 350 or 400; and the number of machines is so great, that it is possible to coin, in the space of a year, without displaying an extraordinary activity, more than thirty millions of piastres, that is to say, nearly three times as mush as is generally performed in the sixteen mints which exist in France. At Mexico there was coined, in the month of April alone, in the year 1796, the sum of 2,922,185 piastres; and in the month of December, 1793, more than 3,065,000 piastres. At Paris in the year 1810, the strongest month of coinage was the month of March, when there was coined in pieces of five francs, the value of 1,271,000 piastres. Between 1726 and 1780, the coinage of gold and silver amounted to.

In the sixteen Mints of France. *	In the Mint of Mexico.
2,446,000,700 liv.	3,364,138,060 liv.

* *Necker, de l'Admin. des Finances*, t. iii. p. 59.

To give an idea of the activity of the mint of Mexico, we shall insert here one of the tables which the government orders every year to be printed for the information of the public respecting the state of the mines, that are considered as the regulator of the public prosperity. I shall select the year 1796, when the coinage amounted to 25,644,000 piastres *, although it had been 24,593,000 in 1795, and was 25,080,000 piastres in 1797.

Months of the year 1796.	Gold Piastres.	Silver.		Gold and Silver.	
		Piastres.	Reals.	Piastres.	Reals.
January -	- -	- -	- -	- -	- -
February -	- -	2,078,958	7½	2,078,958	7
March - -	246,578	2,071,001	0½	2,317,579	0½
April - -	- -	2,922,185	1	2,922,185	1
May - -	252,240	2,538,847	4½	2,791,087	4½
June - -	- -	1,907,980	3	1,907,980	3
July - -	117,008	2,028,327	6	2,145,335	6
August -	- -	1,551,143	2	1,551,143	2
September	161,312	2,257,900	3½	2,419,212	3½
October -	- -	2,455,057	3	2,455,057	3
November	110,112	2,685,903	1¼	2,796,015	1¼
December	410,544	1,849,467	0¾	2,260,011	0¾
Total	1,297,794	24,346,772	0½	25,644,566	0½

The works of the mint of Mexico contain ten rollers (*laminoirs*), moved by sixty mules, fifty-two cutters (*coupoirs*), nine adjusting tables (*bancs d'ajustage*), twenty machines for marking

* 5,385,200*l.* sterling. *Trans.*

the edges (*à creneler*), twenty stamping presses (*balanciers*), and five mills for amalgamating the *washings* and *filings* called *mermas*. As one stamping press can strike in ten hours more than 15,000 piastres, we are not to be astonished that with so great a number of machines they are able to manufacture daily from fourteen to fifteen thousand marcs of silver. The ordinary work, however, does not exceed from eleven to twelve thousand marcs. From these data, which are founded on official papers, it appears that the silver produced in all the mines of Europe together would not suffice to employ the mint of Mexico more than fifteen days.

The expence of carriage, including the salaries of the officers, and the loss occasioned by the mermas, amount to a real de plata or 13 sous per marc. This loss from the *mermas*, which was formerly computed at one third per cent., is now reduced to the half; for, instead of three marcs, they do not lose more than one marc and three ounces in each thousand marcs coined. With respect to the profit derived by the king from coinage, it is estimated in the following manner: if the coinage does not exceed fifteen millions of piastres per annum, the profit is only six per cent. of the quantity of gold and silver coined; when it amounts to eighteen millions of

piastres, the profit is $6\frac{1}{2}$ per cent.; and it rises to seven per cent. when the produce of the mines is still greater, as was the case during the last twenty years. We shall afterwards see that the mint of Mexico, and the house of separation (*maison du depart*), make an annual profit of nearly eight millions of francs.*

The house of separation (*casa del apartado*) in which is carried on the separation of the gold and the silver, proceeding from the ingots of auriferous silver, formerly belonged to the family of the Marquis de Fagoaga. This important establishment was only annexed to the crown in 1779. The building is very small and very old; and it has latterly been rebuilt, in part, at a greater expence to the government than if its place had been supplied by a new house, not situated in the middle of the town, and in which the acid vapours would have been better directed. Several persons interested in the works of the *apartado* remaining in their present situation, maintain that the vapours of nitrous acid which are diffused through the most populous quarters of the town, serve to decompose the miasmata of the surrounding lakes and marshes. These

* 326,830*l.* sterling. *Trans.*

ideas met with a favourable reception after acid fumigations were used in the hospitals of the Havannah and Vera Cruz.

The *casa del apartado* contains three sorts of works, which are destined, 1st, to the manufacture of glass; 2nd, to the preparation of nitrous acid; and 3rd, to the separation of the gold and the silver. The processes used in these different works, are as imperfect as the construction of the glass-work furnaces, used for the manufacture of retorts, and the distillation of aqua fortis. The substance of the glass (*pasteladura*) is composed of 0.46 of quartz, taken from the veins of Tlapujahua, and 0.54 of soda, which the Indians of Xaltocan and the Peñol procure from the incineration of the Sesuvium portulacastrum of several new species of Chenopodium, Atriplex, and Gratiola, which will be described in the *Flora Mexicana* of M. M. Sesse and Cervantes, and of the Salsola soda of Europe, which is cultivated in the valley of Mexico, both to be eaten as a root, and to be reduced to ashes. This soda of Xaltocan is mixed with a good deal of sulphate of potash and lime; so that the carbonate of soda, which is every where found in efflorescence in clay grounds, would be much better adapted for the manufacture of glass. This *pasteladura* is not melted in earthen pots as in Europe, but in crucibles

of a very refractive porphyritic rock, procured in a quarry in the vicinity of Pachuaca. More than 15,000 francs are annually consumed in the glass-house furnaces for wood. A retort costs nearly 14 sous at the manufactory, and more than 50,000 are annually broken.

The nitrous acid used for the separation, is manufactured by decomposing raw saltpetre, by means of a vitriolic earth (*colpa*) which contains a mixture of alumine, sulphate of iron, and oxide of red iron. This *colpa* comes from the environs of Tula, where a mine is worked at the expence of the *Farm of Colours.** The saltpetre is furnished to the *House of Separation*, by the royal manufactory of powder. Each retort is charged with eight pounds of *colpa*, and the same number of pounds of nitrate of impure potash; the distillation lasts from thirty-six to forty hours. The furnaces are round, and unprovided with grates. The nitrous acid which is derived from the decomposition of a saltpetre surcharged with muriate, necessarily contains much muriatic acid, which is carried off by adding nitrate of silver. We may judge of the enormous quantity of muriate of silver obtained in this establishment, if we reflect that there is purified a quantity of nitrous acid, sufficient

* *Estanco real de tintes y colores.*

to separate seven thousand marcs of gold per annum. They decompose the muriate of silver by fire, melting it with small lead drops. It would be more profitable, undoubtedly, to make use, in the distillation of aqua fortis, of refined, instead of raw saltpetre. They have hitherto followed the slow and laborious method of purifying the acid by nitrate of silver, because the *royal establishment of the apartado* is under the necessity of buying the saltpetre from the *royal manufactory of powder and saltpetre*, which will not give out refined saltpetre, under 126 francs the quintal.

The separation of gold and of silver reduced to grains, for the sake of multiplying the points of contact, takes place in glass retorts arranged in long files on hoops, in galleries from five to six metres in length.* These galleries are not heated by the same fire, but two or three matrasses form as it were a separate furnace. The gold which remains at the bottom of the matrass, is cast into ingots of fifty marcs, while the nitrate of silver is decomposed by fire during the distillation in the retorts. This distillation, by which they regain the nitre and acid, is also practised in a gallery, and lasts from 84 to 90 hours.

* From 16 to 19 feet. *Trans.*

They are obliged to break the retorts to obtain the reduced and chrystallized silver. They might no doubt be preserved, by precipitating the silver by copper, but it would require another operation to decompose the nitrate of copper, which would succeed to the nitrate of silver. At Mexico, the expence of separation, is reckoned at from two to three reals *de plata* (from 26 to 39 sous tournois) per marc of gold.

It is surprising that none of the pupils of the school of mines are employed either in the mint, or in the *casa del apartado;* and yet these great establishments ought to expect useful reforms, from availing themselves of mechanical and chemical knowledge. The mint is also situated in a quarter of the town, where running water might be easily procured to put in motion hydraulical wheels. All the machines are yet very far from the perfection which they have recently attained in England and in France. The ameliorations will be the more advantageous, as the manufacture embraces a prodigious quantity of gold and silver; for the piastres coined at Mexico, may be considered as the materials which maintain the activity of the greatest number of the mints of Europe.

Not only working gold and silver, of which we have already spoken, has been improved

in Mexico; but very considerable progress has also been made in other branches of industry dependent on luxury and wealth. Chandeliers, and other ornaments of great value, were recently executed in gilt bronze, for the new cathredal of Puebla, of which the bishop possesses more than 550,000 livres of revenue.* Although the most elegant carriages driven through the streets of Mexico and Santa Fe de Bogota, at 2300 and 2700 metres† of elevation above the surface of the ocean, come from London, very handsome ones are also made in New Spain. The cabinet-makers execute articles of furniture, remarkable for their form and the colour and polish of the wood, which is procured from the equinoctial region adjoining the coast, especially from the forests of Orizaba, San Blas, and Colima. It is impossible to read without interest in the gazette of Mexico‡, that even in the *provincias internas*, for example at Durango, two hundred leagues north of the capital, harpsichords and piano-fortes are manufactured. The Indians display an indefatigable patience in the manufacture of small toys, in wood, bone, and wax. In a country where the vegetation affords the most precious productions*, and where the workman may choose at will the accidents of colour and form among the roots, the medullary prolongations of the wood, and the kernels of fruits, these toys of the Indians may one day become an important article of exportation for Europe. We know what large sums of money this species of industry brings in to the inhabitants of Nuremberg, and the mountaineers of Berchtolsgaden, and the Tyrol, who however, can only use in the manufacture of boxes, spoons, and children's toys, pine, cherry, and walnut-tree wood. The Americans of the United States send to the island of Cuba, and the other West India Islands, large cargoes of furniture, for which they get the wood chiefly from the Spanish colonies. This branch of industry will pass into the hands of the Mexicans, when, excited by a noble emulation, they shall begin to derive advantage from the productions of their own soil.

We have hitherto spoken of the agriculture, the mines, and the manufactures, as the three principal sources of the commerce of New Spain. It remains for us to exhibit a view of the exchanges which are carried on with

* 22,448*l.*

† 9,387 and 11,020 feet. *Trans.*

‡ *Gazeta de Mexico*, t. v. p. 369.

* Swietenia Cedrela and Caesalpinia wood; trunks of Desmanthus and Mimosa, of which the heart is a red, approaching to black.

the interior, the mother country, and with other parts of the New Continent. Thus we shall successively treat of the interior commerce, which transmits the superfluous produce of one Mexican province to another; of the foreign commerce with America, Europe, and Asia; and the influence of these three branches of commerce on the public prosperity, and the augmentation of the national wealth. We shall not repeat the just complaints respecting the restriction of commerce, and the prohibitory system, which serve for basis to the colonial legislation of Europe. It would be difficult to add to what has been already said on that subject, at a time when the great problems of political economy occupy the mind of every man. Instead of attacking principles, whose falsity and injustice are universally acknowledged, we shall confine ourselves to the collection of facts, and to the proving of what importance the commercial relations of Mexico with Europe may become, when they shall be freed from the fetters of an odious monopoly, disadvantageous even to the mother country.

The *interior commerce* comprehends both the carriage of produce and goods into the interior of the country, and the coasting along the shore of the Atlantic and Pacific Oceans. This commerce is not enlivened by an interior navigation on rivers or artificial canals; for, like Persia, the greatest part of New Spain is in want of navigable rivers. The Rio del Norte, which from its breadth hardly yields to the Mississipi, flows through regions susceptible of the highest cultivation, but which in their present state exhibit nothing but a vast desert. This great river has no greater influence on the activity of the inland trade, than the Missouri, the Cassiquiare, and the Ucayale, which run through the savannahs and uninhabited forests of North America. In Mexico, between the 16° and 23° of latitude, the part of the country where the population is most concentrated, the Rio de Santiago alone, can be rendered navigable at a moderate expence. The length of its course*, equals that of the Elbe and the Rhone. It fertilizes the table lands of Lerma, Salamanca, and Selaya, and might serve for the conveyance of flour from the intendancies of Mexico and Guanaxuato, towards the western coast. We have already proved†, that if, on the one hand, we must renounce the project of establishing an inland navigation between the capital and the port of Tampico, on the other, it would be very easy to cut canals in the valley of Mexico,

* The Rio Santiago, the old Rio Tololotlan, is more than 170 leagues in length.

† Chap. iii. and viii.

from the most northern point, the village of Huehuetoca, to the southern extremity, the small town of Chalco.

The communications with Europe and Asia, being only carried on from the two ports of Vera Cruz and Acapulco, all the objects of exportation and importation necessarily pass through the capital, which has become through that means the central point of the interior commerce. Mexico, situated on the ridge of the Cordilleras, commanding as it were the two seas, is distant in a straight line from Vera Cruz 69 leagues, 66 from Acapulco, 79 from Oaxaca, and 440 leagues from Santa Fe of New Mexico. From this position of the capital, the most frequented roads, and the most important for commerce, are, 1st, the road from Mexico to Vera Cruz, by Puebla and Xalapa; 2d, the road from Mexico to Acapulco by Chilpanzingo; 3d, the road from Mexico to Guatimala, by Oaxaca; 4th, the road from Mexico to Durango and Santa Fe of New Mexico, vulgarly called *el camino de tierra dentro*. We may consider the roads which lead from Mexico, either to San Luis Potosi and Monterey, or to Valladolid and Guadalaxara, as ramifications of the great road of the *provincias internas*. When we examine the physical constitution of the country, we see, that whatever may one day be

the progress of civilization, these roads will never be succeeded by natural or artificial navigations, such as we find in Russia, from St. Petersburgh to the centre of Siberia.

END OF VOL. III.

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