EARLY SILVER MINING IN NEW SPAIN

The almost complete absence of objects made of silver from the lists of inventories of shipments sent to Spain immediately before and after the conquest of Mexico cannot fail to strike our attention in comparison with the profusion of gold objects among them. The principal work of silver was the wheel, forwarded by Montejo and Puertocarrero in July, 1519. This was accompanied by some small silver shields, but even with the wheel they only totaled some sixty-two marks, or roughly five hundred ounces of silver. Montezuma's treasure house held some silver, how much is not stated, except that Cortés in his second letter says that the king's *quinto* of silver amounted to 100 marks or more which he had made up into plates, cups, and spoons.[1] Bernal Díaz del Castillo says they did not value the silver in Montezuma's treasure, indicating that it was of small value.[2] We can be sure that none of this silver was carried away by the Spanish soldiers on the *Noche Triste*. Even in López de Gómara's list of the objects brought back by Grijalva there is not a single one of silver.[3] Mendoza in 1550 asserted that the Mexican did not know silver and did not use it.[4]

[1] *Letters of Cortés by* FRANCIS AUGUSTUS MACNUTT. New York, 1908, I, 254.

[2] *Historia Verdadera de la Conquista de Nueva España.* México, 1904, I, 342.

[3] *Conquista de México* by FRANCISCO LÓPEZ DE GÓMARA. Edition of Vedia, Madrid 1852, page 298.

[4] *Colección de documentos inéditos relativos al descubrimiento de América.* Tomo VI, 500.

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None of the accounts of the conquest that I have seen makes more than incidental mention of silver in Mexico City. *Licenciado* Zuazo in his letter from Cuba of November 4, 1521, says that the Indians have much silver out of which they make large vessels like the Spanish ones. He saw some, he said, that were not so well made as those made by the Spaniards. He also talked about the Señora de la Plata who lived somewhere in the southwest of Mexico and had the pillars of her house made of silver.[5] Zuazo, however, had never been in Mexico at this time and this was all hearsay. The legend was heard from later. When Cortés sent messengers to Michoacán, however, some silver was found which was always referred to as low-grade silver. Gómara says 1,000 marks mixed with copper were brought back by Olid.[6] Cortés himself in his fourth letter speaks of getting 3,000 marks from Michoacán which he says was perhaps one-half silver and one-half copper.[7] It is probable that out of this silver Cortés had his famous fenix cannon made in 1524. In describing the manufacture of this cannon he says that it required 2,450 pounds (probably he means silver) in which there was even some gold. He says that it cost 24,000 *pesos* of gold counting the mark of silver at $5 of gold.[8] It is therefore plain that there was a large admixture of something besides silver, which I take to have been copper. Diego de Soto, who took the fenix to Spain in November, 1524, also took some silver trinkets. In 1525 the silver objects sent to Spain had increased in number and importance, some shields being specified which weighed together twenty-four marks.[9]

[5] *Colección de documentos para la historia de México* publicada por JOAQUÍN GARCÍA ICAZBALCETA. México 1858, page 562.

[6] *Conquista de México*, page 294.

[7] *Letters of Cortés*, II, 162.

[8] *Idem*, 211.

[9] *The Goldsmith's Art in Ancient Mexico* by MARSHALL H. SAVILLE. New York 1920, page 85.

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Bernardino de Albornoz, the chief accountant, wrote December 15, 1525, that they were sending, by one Moscoso, to Española for remittance to Spain 102 marks of silver.[10] In this letter occurs the first specific reference to silver mines that I have seen. There are numerous others to "*minas de oro y plata*" but this is simply a general phrase meaning mines of precious metals. Albornoz states that it was necessary to erect in Michoacán a house where the ore from which silver was obtained could be smelted; once smelted it could be brought to Mexico to be remelted and refined, as silver does not come out clean at once like gold. This is necessary, he said, in order that the silver may pay the *quinto* and *diezmos*, since the Indians and even the slaves and the Christians have been accustomed to smelt it each in his own house and even refine it, so that they evade paying duty to the king except by a miracle, as they keep quiet about what they take out. He goes on to say that at the port the shippers suborn the officials and threaten them, implying that the laws were not sufficiently repressive. This statement would lead us to believe that the trade was of some importance. He adds that the Indians are discovering many silver mines in Michoacán but do not work them for fear of Cazonci [the Tarascan chief].

In the *Relación de las ceremonias y ritos y población y gobernación de los Indios de la Provincia de Mechuacan*[11] there are numerous references to *rodelas de plata* or silver shields. This account was written for Antonio de Mendoza at some date, perhaps before 1540. In this account occurs the relation of how the Spaniards came to the province.[12]

First came messengers from Montezuma to ask aid against the Spaniards. These brought as presents some *rodelas* surrounded by gold. The Spaniards were then approaching

[10] *Colección de documentos...* ICAZBALCETA, I, 502.

[11] Morelia, 1903.

[12] *Idem*, page 80 *et seq.*

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Mexico. Then three Spaniards came [no doubt Montaño and his companions] and later Cristóbal de Olid in July, most likely in 1522 as the Mexicans were then reported to all be dead. The Spaniards began to search for gold in the house of Cazonci, the chief, and an account follows of the treasure which had been accumulated in chests by the chief's predecessors. Much of this was in silver shields. Some silver is also mentioned. Much of this Olid carried to Mexico, Cortés being then in Coyoacán. I cannot find in the *Relación* any mention of mines of silver or methods of obtaining it. Afterward much more silver was obtained, usually stated to be in *rodelas*. These facts and the inclusion of silver shields even in the first shipment of loot to Spain in 1519, lead us to suspect that they had been obtained by the Mexicans in Michoacán.

The boundaries of the province of Michoacán as it existed at the time of the conquest are uncertain, as were those of the bishopric of Michoacán, much later. It seems likely, however, that part of the present State of Mexico, lying west of Toluca was included. The Tarascan territory certainly extended to the Pacific and included what is now Zacatula. In present Michoacán there are other silver districts besides those now in the State of Mexico, for example, Angangueo and Tlalpujahua. A peculiarity of the Michoacán silver was its impurity and several times mention occurs of the silver being mixed with copper, a most unusual product at such times. I found instances where the silver was valued at only two *pesos* per mark. Even if these were *pesos de minas* it would indicate that the silver was only 500 fine. By 1523 or 1524 Michoacán was pretty well divided into *encomiendas* by Cortés. About 1550, when these towns were visited and an appraisement of their tribute made, many of them were producing small quantities of low-grade silver; in some cases the tribute exacted was as little as one mark every eighty days. The output was so small as to be negligible and this is

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indicated plainly enough in the shipments of silver to Spain before 1536.

I have seen no description of the methods by which the Tarascans obtained this silver. It is hardly possible that they had enough knowledge of metallurgy to mix silver ores with copper ores so as to use copper as a collector, as in modern metallurgical practice. It would seem much more likely that they had smelted some ore containing the two metals. Copper ores, however, containing such a high percentage of silver are extremely uncommon, but it seems possible that there must have been some deposits of it somewhere in the country, small as they evidently were. From the reference of Albornoz to smelting it seems probable that they were smelting these ores, or at least melting the mineral. They could hardly have had any idea of reduction of ores by the use of charcoal as a reducing agent. The Spaniards, however, understood the method of smelting lead ores with silver. I do not understand the later allusions to grinding the ores unless they had such small furnaces that it was necessary to get the ore in a fine state, before they could smelt it. The mention of bellows in the *Ordenanzas* of 1532 indicates that artificial blast was used. Later there is an allusion to the use of reverberatory furnaces of smelting. This method, known to us as the scorification method, was later in great use in the north.

Writing in October, 1524, Cortés explains his efforts to make cannon. He said he purchased copper and as tin was required he procured some from tin plates or other vessels which he bought with great difficulty and expense. Even so but little could be found. Finally, some more tin coins were found in Tachco [Tasco]. As he found that this tin was being mined in Tasco he sent some Spaniards who brought back a sample and he says that from now on he thought that the necessary quantity could be extracted.[13] This must

[13] *Letters of Cortés II*, 204.

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have taken place some time in 1524, but there is no indication that silver was found in Tasco until possibly 1534. It is to this period that Dr. Alonso de Zorita refers in speaking of the Valle de Matlaltzinco. He says that the Marqués del Valle took Toluca for himself, asked for Indians to work on his houses in Mexico and afterward asked for slaves to work in the mines of Tletiztlac. This Tletiztlac was obviously Teulistaca, close to Tasco, perhaps where the mines were located. Dr. Zorita then adds that after the mines of Tasco and Zultepec were discovered the Marqués del Valle asked for Indians to take out silver from them and asked for sixty in perpetual service.[14]

In 1525 a silver mine was discovered which was so rich that the government took possession of it, but before much work could be done on it the mine was lost or the ore played out.[15] If there is any truth in this story it would seem likely that a large deposit of chloride or bromide of silver had been discovered on the surface and that when this had been taken out there was either nothing under it or else ore of too low grade to be treated. In the instructions given to Nuño de Guzmán in Madrid April 5, 1528, it is stated [Trans.] "I have received an account that in the province of Michoacán, forty leagues from Tenochtitlan, Mexico, there is a mountain from which, taking the earth and smelting it, a great part of silver is recovered, although up to the present time, no effort has been made to work it."[16] In the second instructions to the *Audiencia* in pointing out the towns which should be the head towns there is a list of those to be taken for the king in which we find Tamaçula, "where there are the mines of silver."[17] From this it would appear that Ta-

[14] *Pomar y Zurita,* México 1891, page 222.

[15] *Conquista de México,* 394.

[16] *Provisiones, cédulas, etc. de Nueva España.* México 1878 (reprint of the edition of 1563) page 70.

[17] *Idem,* page 82.

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maçula may have been the place where silver had been discovered, perhaps in the mine that was lost. Tamaçula was probably the Tamaçula in Colima. According to a geographical account of the diocese of Tlascala, written about 1550 there is a mention of this town which is stated to be two and one-half days' journey from Colima and five and one-half days' journey from the city of Michoacán. It is stated to be "*tierra de minas de plata.*"[18] The province of Colima was invaded by Cortés' men on several occasions: First by Cristóbal de Olid, probably in 1522; then by Gonzalo de Sandoval in the following year; and finally in 1524 by Francisco de Cortés. No account of these expeditions is extant to my knowledge but the persistence with which Cortés kept sending expeditions there seems to indicate that there were some mines in the province. There were some gold mines in the Motines and also in Colima proper but later they do not appear to have been very rich. I do not know the present name of the town of Tamaçula. It was then near Tuxpa which was also a mining *real* in 1550.

In 1532 and 1533 the letters of the *Audiencia* and the royal officials frequently mention new discoveries of silver but no statement is made as to where the mines were located. The first letter is of September 17, 1532.[19] November 3 in a letter reference is made to the discoveries of rich mines in Michoacán and to ordinances for the new mines which are being sent to Spain.[20] These were issued May 2, 1532, and contain some interesting facts.[21] A *cédula* of April 20, 1533,

[18] *Papeles de Nueva España.* Madrid, 1905, Tomo I, 221.

[19] *Colección de Documentos... de América.* Tomo XIII, 233-37.

[20] *Idem,* 250-61. Printed in *Epistolario de Nueva España* II, 219, (Note I).

[21] Manuscript in Real Academia de Historia, Muñoz papers, *Tomo 79,* Folio 157(extract in *Apuntes para una Biblioteca Española de libros etc. de riquezas minerales* by EUGENIO MAFFEI and RAMÓN RUA FIGUEROA, Madrid 1871-2, 2 vols. No. 3579). Another set of ordinances relating to the treatment of the Indians in the silver mines, dates June 30, 1536, is also extracted in this work, No. 1596. It is also in the Real

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dated in Barcelona evidently refers to these letters as it mentions the ordinances just referred to. The ordinances were declared good. The *cédula* then proceeds to say: "It appears from this that there might be some inconvenience in safeguarding our *hacienda* by having bellows and smelting outside the smelting house, and therefore I charge you to investigate this matter to see what our officials in that country should do and advise us of the resolution which you take. Meantime, if you do not make some provision so that no inconvenience may result you may postpone the compliance of your orders."[22]

I have photostats of the letters of the *Audiencia* of April 19 and July 10, 1532, neither of which contains anything relative to the mines but the former does speak of silver in Michoacán. A letter from the *Oficiales Reales* in Mexico of May 1, 1533[23] states that the first mines of silver had been discovered eight or nine months previously. A letter of August 5, 1533, speaks of the mines of silver as multiplying more and more, richer ores being discovered every day but not of gold. A statement is then made that it has now been found out how to refine silver without losing the *cendrada*.[24] Apparently a *cendrada* was a cupel. The expressions that have been used in connection with the smelting operations would indicate that the ores contained some lead and were smelted in small blast furnaces producing lead bullion which contained the silver. The operation of cupelling this bullion to secure the silver was wellknown at the time, and the litharge resulting from it was used again to smelt silver ores.

The most authentic account that we have of the discov-

Academia *Tomo* 80. An *acuerdo* in Mexico, September 10, 1533, about smelting silver and ordering bellows to be used is also in the Muñoz papers *Tomo 79*, and extracted in the same work briefly in No. 2798.

[22] *Cedulario de Puga*, page 293.

[23] *Papeles de Nueva España* VI, 267 (Note 1).

[24] *Idem*.

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ery of silver except those relating to the Michoacán mines, whose location we do not know, is that of those at Zumpango. Zumpango is on the road from Acapulco to the City of Mexico not far from Chilapa. Diego de Hoyos who made a declaration about 1547 in Mexico City, said that he took part with Vasco Porcallo in the Yopelcingo campaign and on his way back was one of the first to discover silver at this place.[25] This campaign took place in 1531. Orozco y Berra draws a definite conclusion that the mines were discovered in 1532. Another man who also declared about 1547, Rodrigo de Tamara,[26] claims the honor of having been the first discoverer of these mines. He says that they were named San Martín de Zumpango. As it was customary to name places after saints at that time it is quite possible that the discovery was made November 11, the day of San Martín, and therefore probably in 1531. There is some further contemporary evidence. Luis Rodríguez,[27] a silversmith who also declared about 1547 that he came in 1530 said that he had worked up into clean silver the first silver metal found in the country and claimed that this was from Zumpango. Juan Jaramillo[28] at the same date, declared that his uncle, Diego, discovered the first mines in Zumpango. Another man named Benito Muñoz[29] was also a member of the Yopelcingo expedition and says he was one of the first discoverers of silver, no doubt also in Zumpango. Another man, Diego de Castañeda,[30] who also seems to have taken part in the Yopelcingo campaign and was then residing in Zumpango, said that he was also one of the first discoverers

[25] *Conquistadores y pobladores de Nueva España* by FRANCISCO A. DE ICAZA. Madrid 1925, No. 1247.

[26] *Id.* No. 1320.

[27] *Id.* No. 772.

[28] *Id.* No. 867.

[29] Id. No. 1093.

[30] *Id.* No. 1339.

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of mines. Another, Juan Talavera made the same claim about 1548.[31]

In the account of Zumpango, written March 10, 1582, in Zumpango, it is stated that the silver mines were discovered forty-eight years before and the discoverer's name was Diego Jaramillo, one of the men mentioned above. If we take this date as exact we would arrive at the fact that the mines were discovered in 1534.[32] Everything really hinges on the date of the Yopelcingo campaign which, however, no doubt took place in 1531 and not in 1534.

It is probable that the mines at Tasco were discovered shortly afterward. In 1536 Indians from Iguala were allotted to these mines.[33] Other convincing evidence of this is to be found in the declaration made by Guido de Lavezares about 1550.[34] He came in 1536, evidently with Johann Engel, a German, and other employees of Lazaro Norimberger, and Christoff Reiser [Keyser], both Germans. These names are written in Lavezares' account as Lazaro Martin Verger and Cristobal Rrayzer and Engel's name as Juan Enchel. Lavezares claimed that they brought apparatus and skill for smelting silver ores which up to that time were not known and they made engines to grind and smelt the metal from which much advantage accrued to the Republic. He claimed that they lost 10.000,000 *maravedís* in the operations. Norimberger was the brother-in-law of Juan Cronberger and there is evidence to show that they were in partnership in business in America. In the documents published by the widow of José Gestoso y Pérez, *Noticias Inéditas de Impresores Sevillanos,* there are several notices of Lavezares who first appears in 1540. On July 4 Cronberger issued a power of attorney to Bishop Zumárraga to adjust accounts with

[31] *Id.* No. 990.

[32] *Papeles de Nueva España* VI, 317.

[33] *Boletín del Archivo General, Tomo VII,* page 193.

[34] ICAZA No. 1156.

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Lavezares for all the goods that he had brought from Seville to sell in Mexico. July 13 Cronberger issued another power of attorney to Juan Rodríguez de Morales. In the power of attorney which Cronberger's wife issued to Bishop Zumárraga, September 22, 1540, it is stated that he should visit the mines of silver which he owned in New Spain. On the 25th of May, 1542, Lazaro Norimberger executed a contract of liquidation of all accounts which he had with Juan Cronberger and his wife, excepting the production of the mines in New Spain and the money which Guido de Lavezares owed. This entirely confirms the statements of Lavezares of 1550. No mention is made of the particular mines which they had worked. The sending of a technical German with apparatus to Mexico in 1536 in order to work silver mines, shows plainly enough that mines had been discovered before that time. The Tasco mines are generally supposed to have been discovered in 1534 which would have given time enough for the news to have reached Seville and to send back employees to work them.

It is not, however, certain that these mines were in Tasco. There is extant a document of Viceroy Mendoza of June 7, 1542, relating to some mines at Zultepec which then belonged to the sons of Cronberger and were in charge of Rodrigo de Morales. This man probably succeeded Lavezares who in that same year went with Villalobos on his expedition to the Spice Islands. June 8, 1543, a grant of land was made to Morales for a site for a mill to smelt metal at Tescaltitlan, a place near Zultepec. I quote a translation from the gift of 1542 taken from the original quoted by Joaquín García Icazbalceta. "I Don Antonio de Mendoza make known to you, Martín de Peralta, *alcalde mayor* of the silver mines in the province of Zultepec or to whomever is your *teniente* in the said office, that Rodrigo de Morales has advised me that he is the administrator of the mines, mills, and slaves which the Germans formerly had and which

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now belong to the children of Juan Cronberger and in which property there are said to be twelve people with slaves and Indians on service and that for sustaining them, he has need of two *caballerías* of land where wheat and corn may be sown and a *sitio* for cattle ranches."[35] This Morales was no doubt the same man to whom Cronberger had issued a power of attorney. The order of 1543 was issued to Alonso Carreño for the widow and children of Juan Convergel, for a site on the river for a mill for smelting metal.[36]

Besides the mines just mentioned and those in Zumpango several other camps had been discovered before 1550. Prominent among these were the mines of Ayoteco near Chautla, very possibly those still known as the Huatla mines. Zacualpa had been discovered: some mines called Guachinango in New Galicia, some near Tepic, and some others also in New Galicia named *Spiritu Santo* near Compostela. In 1546 the great mines at Zacatecas were discovered by Juan de Tolosa on September 8 and named *Nuestra Señora* in honor of the Virgin whose birthday it was. The mines, however, are not now supposed to have been opened before 1548, but I am a little doubtful concerning this on account of the following statement of Mendoza about 1550 or 1551. Just as he was leaving for Perú he enlarged upon the difficulty of smelting ores in Mexico owing to the lack of lead, most of which was apparently being brought from Spain. He alluded to the problem of producing much silver at Zacatecas which had just been discovered, and was always very rich, on account of the expense involved in getting lead. He even gives the cost of transporting lead bullion from Vera Cruz to Zacatecas, high enough to make everything but the very highest grade silver ores unprofitable.[37] I judge the same

[35] *Bibliografía Mexicana del Siglo XVI*, page XXVI.

[36] *Idem.*

[37] *Colección de documentos... de América*, XLI, 149-60. In this letter he mentions a number of other mines which had been discovered previously.

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method was used in the districts around Tasco but I have seen no allusion to it at the Zumpango mines. The only other method by which silver could be obtained at that time was by the simple process of melting chloride or bromide of silver. Such minerals are always high in silver and do not require reduction. They can always be melted into comparatively low-grade silver bullion. By cupelling this with lead, high grade silver could be obtained, but it is not likely that for a long time anything but very impure silver was shipped.

The Real del Monte mines near Pachuca were discovered by Alfonso Rodríguez Salzedo, *mayordomo* of a cattle ranch nearby and registered April 29, 1552.[38] Before 1570 other mining camps had been opened, Zimapán, Tlalpujahua, Temascaltepec, Guanajuato, and a few which could have had no long existence. The mines were largely worked by negro slaves. Every description of one of these mining camps mentions this fact. The *encomienda* system was still in force and a number of Indians were drafted to work in the mines in Tasco. A huge draft was made about 1550 on the Tarascan towns for labor at Nuestra Señora de Zacatecas.[39] However, a little later the mining camps were full of free labor. There is no doubt that the great epidemic of 1545 which carried off a number of Indians had something to do with this.

Juan Suárez de Peralta has some interesting notes in regard to mining in the early days. He says that in the time of Mendoza no silver was obtained except by smelting, and that the ores were very rich, even as much as ten to twenty-five marks [probably per *quintal* of 100 pounds] and those as low as three were very poor. The Lord, he said, gave them the benefit of quicksilver, so that they now work ores from

[38] *Descripción de las minas de Pachuca,* Diego Ovalle y Guzmán. [1608]. Manuscript of the Bib. Nac., Madrid, Cod. J. 42 [Extract by MAFFEI y FIGUEROA. No. 1818].

[39] *Boletín del Archivo General, Tomo* VII, No. 2.

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one ounce up. This, he says, was brought about by a *clérigo* in the Pachuca mines who tried out some of the dump and found it to assay more than three ounces. He went to the owner of the mine and made a contract with him to sell him the dump for 100 *pesos*. Suárez says that a gentleman told him that the *clérigo* had gained from this more than 40,000 ducats. This story takes no account of Bartolomé de Medina who is said to have introduced the rudimentary patio process into the country in 1556, although he had announced it to the *Audiencia* in 1554. As Suárez said he knew the gentleman we must take his word for it, I presume. Perhaps he employed Medina or perhaps his name was Medina and he employed somebody from Europe who knew how to treat the ores with salt. Suárez also makes an amusing remark about the charge that Cortés had more silver and gold than there was iron in Vizcaya. He says "If the author had not particularized that the silver was in the possession of Cortés but in the ground he would have been right."[40] Archbishop Moya y Contreras sent home an account of the ecclesiastics in his province March 24, 1575, among whom we find one Garci Sánchez, who he said, had been in the country since 1554, only employed in his own mines.[41] Probably he was the *clérigo* Suárez referred to. In 1569 in a *visita* to these mines Sánchez is mentioned as a *clérigo* who only worked his own mines.[42]

Although I did not propose in this paper to discuss the metallurgical improvements in the treatment of silver, yet the question is such an interesting one that I wish to devote a few pages to it. Amalgamation, by what was known in Mexico as the patio process, was responsible for the largest part of the production of silver in the country down to the

[40] *Noticias históricas de la Nueva España*. Madrid 1878 (although written in 1589). 176-7. 137.

[41] *Cartas de Indias*, Madrid, 1877. No. XXXVII.

[42] *Papeles de Nueva España*, III, 81.

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introduction of smelting by the American companies in the eighties of the last century. The origin of this process is somewhat of a mystery. Several people claimed it. It is generally accepted that Bartolomé de Medina introduced it into the Pachuca mines about 1556 or 1557. As early as 1555 we find some *cédulas* addressed to Luis de Velasco, viceroy of New Spain and to the viceroy of Perú dated Valladolid, September 4.[43] It appears that the government had been advised from New Spain that quicksilver was very useful in smelting and refining silver and instructions were therefore sent out to search for quicksilver mines. At the end of December of the same year the princess, who was then governing the kingdom, wrote a letter to the administrator of the mines of Guadalcanal in Spain, telling him to interview the Germans who were there to find out if they had used quicksilver in their smelting operations, because information had been received from New Spain that it was very useful for that purpose in getting quicker and better results.[44] Even in June, 1557, Francisco de Mendoza, who was administrator of the Guadalcanal mines in Spain, said that a man named Rivas, to whom his Majesty had sent an order to make a contract for getting out silver without fire, had not yet commenced to use his invention but he was very confident that he was going to be successful.[45]

The question is, who was the actual introducer or inventor of the process? Already there was a man named Rivas who had come back from New Spain with it in 1557. In the following year a man named Mosen Antonio Boteller, apparently a Valenciano, came back from Mexico to Guadalcanal, and in 1562 in a memorial to the king called himself the first inventor of extracting silver from metal by the use of quicksilver not only in New Spain but also in this

[43] MAFFEI y FIGUEROA under MEDINA, I, page 458.

[44] *Id.*, page 459.

[45] *Idem.*

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kingdom, giving an account of the assays made in Guadalcanal.[46] In 1616 an investigation was made by the *Audiencia* in Mexico as to the invention of this method of amalgamation. It was then decided that Medina was the inventor, having come to New Spain in 1554, but that Boteller had something to do with it is obvious. In the letter from Mexico dated December 31, 1554, directed to the emperor are the following significant words: "Here has come a certain Señor Bartolomé de Medina of Seville and says that he brought a German (who was not allowed to pass) who knew how to treat silver metals with quicksilver with great advantage over what is now done here and known here and from what he has said he has had experience from which it appears that it would be a great addition if the German could come if there was any quicksilver. The revenue would increase sixfold:"[47] There is no evidence that the German ever came to Mexico, whoever he may have been, although it is possible that Boteller may have been the German under an assumed name.

All that the new process consisted of, so far as I can make out, was the use of quicksilver and salt. On oxidized ores this system will certainly work and presumably that is all they had in the early days at Pachuca. Some years ago, Francisco Fernández del Castillo published some documents from the archives in Mexico, one of which is a memorial to Viceroy Velasco of Bartolomé de Medina dated December 29, 1556, from Xilotepec, in which he set forth that he had heard in Spain in conversation with a German that they could extract silver from metals without smelting and that he had therefore come to New Spain for that purpose and had spent much time and money on it without success. He

[46] MAFFEI y FIGUEROA No. 272. Boteller on his way to Vera Cruz from Cadiz wrote a letter to the king dated January 15, 1556, saying he had arrived at Santiago, Cuba, December 22, 1555, *Doc. Inéditos, Segunda Serie*, tomo III, 434.

[47] *Idem.*

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therefore proposed to give one-quarter of all the profit that he might derive from any concession that might be made him to some charity. Afterward, seeing that the viceroy had made him a concession that nobody in six years could use his process without paying him, it seemed best to him and to the viceroy to devote the money to the school and college of the girls and the orphans in the city of Mexico. In 1567 he confirmed this gift before an *escribano*.[48]

The new process rapidly spread over the country as it was peculiarly adaptable to the oxidized ores found on the outcrops of the veins discovered in the north. It soon reached Perú, in fact, Garci Sánchez, who had been working in Pachuca in 1575, appeared in Potosí, Perú, about 1580 or 1581. All he claimed was that he had been the inventor of the treatment with iron which I think was the first substance which was added in the course of the treatment.[49] About the same time a man named Carlos Corso, was claiming his rights to the same invention.[50] I see no difference except possibly that Corso used finely ground iron, where Garci Sánchez was using iron slags. The addition of iron to the treatment seems to have brought about some improvement, but not for long. The development of the process may be sketched briefly in an instruction written by Juan Ortiz de Zárate in Potosí about 1590. He says that the great riches lasted for twenty-five years which would bring us roughly to 1572. Then amalgamation was begun under Francisco de Toledo and this lasted thirteen or fourteen years. Then the mixture of iron was introduced some four or five years before.[51] In another description of Pachuca written about 1608 by Diego Ovalle y Guzmán he enumerates the different methods by which the ores have been treated in that

[48] *Algunos documentos nuevos sobre Bartolomé de Medina.* México, 1927.

[49] Maffei y Figueroa, No. 978.

[50] *Idem,* No. 516

[51] *Idem,* No. 1807.

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camp by quicksilver, first in stoves, second with salt and quicksilver, a process which was expensive and lasted from four to six months, and third by magistral.[52] He does not say when *magistral* was introduced nor have I found any record of it, but with its introduction the patio process remained practically the same to almost the end of the nineteenth century. *Magistral* is calcined copper sulphide ore and the reactions, although very complicated, became very easily understandable when modern chemistry undertook to fathom the secret of them, but at first it was nothing but a rule of thumb operation. The improvement could not have been introduced much before 1608.

While the introduction of amalgamation of silver into Mexico, as we have seen, is somewhat of a mystery the origin of the process is a still greater one. It would appear from Medina's memorial that he had heard of it from a German in Spain. Mr. Herbert Hoover in his translation of *De Re Metallica* of Agricola has a long Appendix about a book called *Probier Buchlein*, an elementary work on assaying, which he thinks was probably printed first about 1510. The earliest copy that Mr. Hoover found was dated 1524. This book has a reference to recovering silver by the use of quicksilver from the cement resulting from the parting of silver from gold. A somewhat later reference occurs in the *Pyrotechnia* of Vanoccio Biringuccio, in which Biringuccio describes the method of amalgamating gold and silver with mercury by adding vinegar or water in which has been dissolved corrosive sublimate, verdigris and salt. The mixture is covered with mercury and then is mixed by a machine which is turned either by hand or by a horse for an hour or two. The mercury is then recovered by a sieve or by washing. Then, he says, the mercury is drawn off in a flask and all the metal, gold, silver and copper will be recovered. Biringuccio then goes on to say that he considered this se-

[52] *Idem*, No. 1818

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cret so desirable that he gave a man a ring with a diamond worth twenty-five ducats for it and agreed to pay one-eighth part of what he got out of it.[53] This seems to be nothing more nor less than the patio process as first installed in Pachuca with the possible exception that corrosive sublimate was not added there so far as we know. There is no mention in Agricola's book of the process, nor does it appear likely that the Germans who came to Spain at the time of the Guadalcanal discovery knew anything about it. The process was introduced there from New Spain, and in fact it was not adopted in Germany for 200 years, probably because the ores were not suitable for it, being far too rebellious. As we have seen, the process of smelting in furnaces probably was introduced in New Spain in 1536 by Germans and the various references to their proceedings would indicate that they were using the methods then in common use in Germany, that is, smelting in blast furnaces. Reverbatory furnaces do not seem to have been used in Germany but Biringuccio describes one, and as I have previously stated this process was finally used extensively in Mexico.

In 1569 Bernardo Pérez de Vargas published a book in Madrid entitled *De Re Metallica.* This book contains numerous references to George Agricola. It contains no mention of amalgamation of silver ore by the use of quicksilver, although he does mention Biringuccio. There is, however, in the book a curious certification by one Diego de Meneses, a citizen of Madrid, recommending the book. He declared that he had had mines and worked them and treated ores in Perú and in New Spain and in other places for more than thirty years. Whether it is a pure coincidence or not, we find a man named Meneses without any Christian name in Medina's list of licencees for his process.[54] He may have been the same man. Pérez de Vargas describes the amalga-

[53] Venice 1540, page 142.

[54] *Algunos documentos nuevos...* page 241.

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mation of gold with quicksilver, taken no doubt from Agricola. Although the Guadalcanal mines had been discovered in August, 1555, and were exceedingly rich at the beginning, Pérez de Vargas only makes two mentions of them, one as follows: [Trans.] "In our times, I am informed that in the mines of Guadalcanal in Spain silver in a fine state has been taken out." An he then quotes Biringuccio to the effect that he had never seen pure metal except copper taken from any mine.

The period from 1545 to 1560 was marked by opening of mines in the northern provinces, later destined to be the richest in the kingdom. In fact they were so from their very discovery. A picture of the situation from 1570 to 1574 can be obtained from Juan López de Velasco's *Geografía y Descripción Universal de las Indias*, published in Madrid in 1894 although written about 1574 or 1575. No mention will be found in this book of the mines which I have indicated as first discovered, those of Tamaçula, Ayoteco or Espíritu Santo. The oldest district still in operation was in the present State of Mexico in the district to which I have previously referred. I give a few interesting notes about these mines, with the number of Spaniards, negroes, and Indians employed in them.

Zultepec	200 Spaniards,	500 negroes, and	200 Indians
Temascaltepec	60 Spaniards,	150 negroes, and	300 Indians paying tribute
Zacualpa	70 Spaniards,	150 negro slaves,	350 Indian miners
Tasco	100 Spaniards,	700 negro slaves,	900 Indian miners
Pachuca	90 Spaniards,		2700 Indians paying tribute
Guachinango (in Xalisco)	30 Spaniards,	100 negro slaves,	(poor mine)
Guanajuato (discovered in 1561)	600 Spaniards,	(mostly traders; mines very rich)	
Zacatecas	300 Spaniards,	500 slaves and more	

At this time the most active mining district was San Martín, discovered in 1554 or 1555. Here there were 400 Spaniards together with those in Nieves, only a short distance

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away. López de Velasco also mentions Fresnillo, Sombrerete, Chalchyutes (near San Martín), San Lucas (north of Durango), Coneto (five leagues still farther north), Avino, and beyond, farther north in Nueva Vizcaya, Indé, Santa Bárbara and San Juan. These latter were said to be very rich and contained much lead which was taken out of them and carried to other mines in New Galicia. Several other *reales* are mentioned in New Galicia which were being worked in a modest way, but he says that most of these mines were poor, only containing two to four ounces per quintal, and many of them were leady.[55] He said that there were some silver mines in the Zapotecas and also in Michoacán which were not worked because the country was too rugged.

There are interesting allusions to mining in the petitions of the *cabildo* of Mexico presented by its *procurador,* Juan Velásquez de Salazar to the Council of the Indies June 6, 1571, about the perpetuity of *encomiendas.* One of the reasons advanced for urging this was the decay of mining. A short history of mining was given. The *cabildo* stated that "from the time Cortés gained the country to 1525 it was sustained by the gold found in the possession of the natives. As this was soon exhausted, all the Spaniards tried to go to Spain or other places as there was neither gold, silver or money for trade. This need the Lord filled by the discovery of gold mines in many parts of the country, and as there were many slaves, those made in war or those whom the natives gave in tribute in conformity with their ancient custom, there were enough people to work the mines. This lasted to 1530 when the product fell off and the Spaniards again tried to go away and many went to Perú as at that time the richness of that country was increasing. In 1532 God was pleased that silver mines should be found and a quantity of it was produced. This eased the minds of the Spaniards. In 1542 the ores began to decline in value and in

[55] *Idem,* page 263.

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smelting qualities. At this opportunity Juan Alemán advised the viceroy, by reason of an account sent him from Germany, of the treatment of rich ores with lead ore and litharge without washing and turning them. By this method a great quantity of silver was extracted and the country was sustained for a few years. The ores kept diminishing in richness and the Indian slaves were freed, so the mining business decayed greatly and the country with it until the Lord again helped. In the year 1553 Bartolomé de Medina came here and gave the first plan of treating ores with quicksilver. With this a greater amount of silver has been extracted than previously by smelting. Therefore, almost everyone dismantled his smelting furnaces and appurtenances and set up stamps to crush the ores, believing that the price of quicksilver would always be moderate as the Germans to whom his Majesty rented the mines were obliged to sell it for (Note, figures uncertain), per quintal. However, the price had now reached excessive figures", evidently more than 100 *pesos* per quintal which the *cabildo* reckoned should only be paid delivered in Mexico City.[56]

The Juan Alemán mentioned must have been the Johann Engel mentioned in the declaration of Lavezares about 1550, although from his declaration it would seem that Engel must have come earlier than 1542.

By 1550 the silver mining industry had taken on such proportions that the viceroy issued some comprehensive ordinances dealing with the subject. These were not the earliest, the first were issued by the *Audiencia* in 1532, as I have stated. Unfortunately, no copy of these seems to have survived. The ordinances now enacted by Mendoza January 13, 1550, contain at the beginning an earlier order dated July 31, 1543, relating to the mines at Chiautla. March 13, 1548, he issued another of more general interest and finally the code which fully covers the methods of denouncing,

[56] *Epistolario de Nueva España,* tomo XI, 1940, No. 569.

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measuring, and registering mines. The essential provision was one that a certain amount of work had to be done on a mine to hold it. A mine that was not worked was subject to denouncement by others. This system lasted for 300 years or more, until the Mexican government instituted one of taxing the properties. Payment of the assessment was sufficient to hold them.[57]

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[57] From one of the originals in the Ayer collection, Newberry library, Chicago.

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