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*On the Mexican Meteorites, with especial regard to the supposed  
occurrence of wide-spread meteoritic showers.*

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*(With maps of the region, Plates I. and II.)*

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[Read May 20th, 1890.]

*Introduction.*

IN a recent paper<sup>1</sup> descriptions were given of some meteoritic masses, which had been brought from the Desert of Atacama and are now in the British Museum. Several of them were independent of those preserved in other Meteorite Collections, in that they showed no signs of having been broken since their discovery; but it still remained to determine whether they might not possibly belong to meteoritic showers, of which individual masses had been already collected and described.

For this a minute investigation of the meteoritic literature of the Desert

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<sup>1</sup> *Mineralogical Magazine*, 1889, vol. 8, p. 223.

of Atacama was necessary. In the course of the investigation, it became clear that the prevalent belief in wide-spread meteoritic showers, whether true or untrue in general, was, as regards the Desert of Atacama, based on insufficient evidence: that in one case the wide-spreading of a shower was undoubtedly caused by a mere interchange of labels; in another by misinterpretations of the statements relative to a locality; that while the places were widely separated from which other fragments, belonging to a single type, had been brought, they were on definite and dangerous lines of traffic, along which similar fragments are known to have been carried on the backs of capricious mules: further, that the statement that "meteorites were found at every step in the Desert" had been made at a time when almost the whole of the Desert was untrodden and unexplored: finally, that the latest explorations did not suggest the existence of meteoritic masses at small distances from each other over any large area of that part of South America.

Attention was thus directed to the following facts:—(1) only nine falls of meteoric iron are known to have been observed since the year 1751; (2) not more than two masses of iron have been seen to fall simultaneously; (3) the largest (Nejed) weighed only 131 lbs.; (4) falls of stones, sometimes thousands in number, have been often observed; (5) the largest authenticated separation for the individuals of a single fall, whether of stone or iron, has been sixteen miles; (6) in some regions meteoric iron will endure for ages before rusting completely away; (7) the discovery of numerous masses of iron in certain districts may be due to the circumstance that the ground has been unexplored, or at least uncultivated, during many centuries.

It has already been distinctly pointed out by Professor Daubrée<sup>1</sup> that the small dispersion of a meteoritic fall is suggestive of the entry into the terrestrial atmosphere of only a single mass, afterwards fractured by the enormous resistance of the air: for the individuals of a swarm of meteoritic masses, various in form and size, would experience resistances so different in magnitude, that the residual masses would probably be scattered over areas of the earth's surface much larger than those which have characterised any of the observed falls.

The converse is not necessarily true, for a wide separation of the terminal individuals of a meteoritic fall might conceivably be due to successive fractures of a single primitive mass. And it may be worthy of remark that, but for the differential action of the atmospheric resistance, the

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<sup>1</sup> *Études Synthétiques de Géologie Expérimentale*, Paris, 1879, p. 672.

dispersion consequent on the breakage of the primitive mass would be very small, however numerous the so-called explosions, since each fragment would retain the enormous velocity belonging to it as part of the original moving body: that by simple division a single mass, or a swarm, could succeed in "dropping" fragments at distant points of the line of flight is mechanically impossible.

Remembering the close similarity in structure and material of the single representatives of meteoritic falls to those which have been picked up in hundreds or even thousands, and the identity in character of the luminous and also of the detonatory phenomena in the different cases, it is difficult to grant that the enormous disparity in the numbers of the individual masses, which have been found after different meteoritic falls, is satisfactorily explained by any possible diversity in structure or velocity of singly entrant blocks.

It cannot be said, however, that all the consequences of the entry into the terrestrial atmosphere of a heavy body, or a swarm of them, with planetary velocity, have yet been satisfactorily worked out: the determination of the maximum observed distribution over the earth's surface of masses belonging to a single meteoritic type would be useful, either as a criterion or as a confirmation of a solution of the mechanical problem.

The evidence for and against the natural occurrence, over a large area, of meteoritic masses belonging to a single and well defined type, is thus not without scientific interest: firstly, as throwing light on the possible occurrence within comparatively recent times of large meteoritic showers such as are not known to have been actually observed; and secondly, as bearing on the true relationship of meteorites and shooting stars.

*Supposed wide-spread showers in other regions.*

The occurrence of wide-spread meteoritic showers has been regarded as established by the distribution of meteoritic masses, not only in the Desert of Atacama, but also in Africa and Mexico.

It is true that masses of meteoric iron, rarely more than one or two hundred pounds in weight, have also been found dispersed in considerable number over the extensive territory of the United States of North America; but it has been as yet impossible, by investigation and comparison of the mineralogical characters of those masses, to obtain any reliable evidence that distant individuals have ever belonged to one meteor.

The evidence relative to a wide distribution in Africa of masses belonging to a single type is extremely slight: when examined it appears to be based solely on the brief statement, made on the authority of Captain

J. E. Alexander,<sup>1</sup> "that there were abundant masses of iron scattered over the surface of a considerable tract of country." In his map the words "much iron" are inscribed close to, and on the east side of, the Great Fish River, in 26° south latitude. But this point is sixty miles from his route as marked on the map, and Alexander gives no description either of the locality or of the mode of occurrence: it is practically certain that he never saw the masses, and that the above information was given to him by a native: in any case, it is not suggestive of a distribution over an extraordinary area. This is confirmed by the reference to the iron made by Captain Alexander in a paper read to the Royal Geographical Society:<sup>2</sup> he states that "there is also *said to be*, to the N.E. of Bethany, near the Great Fish River, a plain covered with large masses of iron, some of which require several men to lift them. I have got specimens of this iron."

#### *Mexican Meteorites.*

But the evidence relative to Mexico is of a much more voluminous character, and is deserving of the closest attention. Mexico is remarkable beyond any other part of the earth's surface for the number and magnitude of the masses of meteoric iron found within its borders: it has been generally assumed that wide-spread showers were necessary to the explanation of their occurrence. Professor Lawrence Smith<sup>3</sup> came to the conclusion that masses belonging to a single meteor were distributed over hundreds of miles of country in Northern Mexico, and his conclusion has been generally accepted:<sup>4</sup> Professor Whitney,<sup>5</sup> and also Señor Urquidí,<sup>6</sup> regarded it as possible that a whole series of iron masses, for a distance of more than a thousand miles through Mexico and the United States, were the result of a single fall: Huntington<sup>7</sup> states that the fact of certain masses having been "found in places so remote from each other does not seem to preclude their having belonged to one individual, since the Rochester meteorite was seen to pass over the States of Kansas, Missouri, Illinois, Indiana, Ohio, and is supposed to have passed over Pennsylvania and

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<sup>1</sup> *An Expedition of Dis. Inter. Africa (countries of the Great Namaquas, Boschmans and Hill Damaras)*, 1838, vol. 2, appendix, p. 272.

<sup>2</sup> *Journ. Roy. Geogr. Soc.*, London, 1838, vol. 8, p. 24.

<sup>3</sup> *Amer. Jour. Sc.*, 1871, ser. 3, vol. 2, p. 338.

<sup>4</sup> *Ibid.*: 1887, ser. 3, vol. 33, p. 116.

<sup>5</sup> *Proc. Cal. Ac. Nat. Sc.*, 1866, vol. 3, part 3, p. 242.

<sup>6</sup> *Bol. de la Soc. Mex. de Geog. y Estad.* Segunda época, 1871, vol. 3, p. 276.

<sup>7</sup> *Proc. Amer. Acad. of Arts and Sciences*, 1888, vol. 24, p. 34.

New York, and thence out to sea, dropping fragments in its course. It therefore is possible that at some remote period an enormous iron meteorite may have passed over the entire breadth of the United States, the main mass reaching Mexico, but large fragments breaking off and falling during its passage across the country : " Professor Barcena<sup>1</sup> is further of opinion that the "peculiar property, difficult of explanation, which the Mexican soil has in attracting the meteoric irons is even noticed at present " (in the attraction of shooting stars).

The following questions thus present themselves for consideration :—

1. What meteoritic falls have been actually observed in Mexico ?
2. In what localities are meteoritic masses said to have been met with ?
3. Is our knowledge of the distribution in these localities at all precise ?
4. Is the climate favourable to the preservation of meteoritic masses ?
5. Are any falls of remote date ?
6. Have any masses been transported from their place of fall ?
7. Had the ancient Mexicans any skill in the transport of heavy blocks ?
8. Had they any respect for meteorites as bodies fallen from the sky ?
9. Is there any evidence of the wide dispersion of masses belonging to a single type ?
10. If so, is the dispersion celestial in origin or due to the action of man ?

#### *1. Meteoritic falls actually observed.*

Only the following seven falls are known to have been actually observed :—

November 24th, 1804.	Hacienda de Bocas, State of San Luis Potosi.
January, 1844.	Loma de la Cosina, State of Guanajuato.
June, 1865.	Hacienda d'Avilez, State of Durango.
June 11th, 1878.	Irapuato, State of Guanajuato.
September 17th, 1879.	Tomatlan, State of Jalisco.
June 18th, 1881.	Pacula, State of Hidalgo.
November 27th, 1885.	Mazapil, State of Zacatecas.

With the exception of Mazapil, the fallen bodies have been essentially stony in character ; in the case of Mazapil, the mass consisted of meteoric iron and weighed only about 8 lbs. : in no case were more than three fragments collected. During the same interval of time, larger showers and more numerous falls have been observed within the British Isles, which are comparatively small in area.

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<sup>1</sup> *Proc. Ac. Nat. Sc. Philadelphia*, 1876, p. 126.

Doubtless other meteoritic falls have been observed in Mexico, though the masses have not been preserved: as stated below, the companions of Cortes, for example, are said to have seen a meteorite at Cholula which had fallen on the neighbouring pyramid.

A fireball, probably meteoritic, caused much terror to the Mexicans in the year 1521: "many, after the siege, declared that among other prodigies, they beheld a stream of light of a blood-red colour, coming from the north in the direction of Tepejacac, with a rushing noise like that of a whirlwind, which swept round the district of Tlatelolco, darting out sparkles and flakes of fire, till it shot far into the centre of the lake" (Prescott).

### 2. *Localities in which meteoritic masses have been found.*

A statement of the precise localities in which masses, recognised as being of meteoric origin, have been met with is given below: at this stage we need merely observe that the localities are only in the following States (Plate I.):—

I. Coahuila and Nuevo Leon; II. Chihuahua; III. Sinaloa; IV. Durango; V. San Luis Potosi; VI. Zacatecas; VII. Mexico and Morelos; VIII. Oaxaca; IX. Guerrero.

### 3. *The distribution in each locality.*

Our knowledge of the distribution of the masses is much more precise for Central and Southern Mexico than for the Northern regions, more especially Coahuila. On the other hand, it is the supposed distribution of meteoric irons in the Bolson de Mapimi, Northern Mexico, that has been largely relied upon as illustrating the occurrence of wide-spread showers. It will be seen, on consideration, that until many years after the publication of the papers of Shepard and Lawrence Smith, no trustworthy information relative to the greater part of that district can have been available, and that any inferences as to wide-spread showers in that region must have been of doubtful value.

The following extracts, from works published at various times during the century, are sufficient to indicate the difficulty which would have been met with, in attempting to get reliable information as to the distribution of meteoritic masses in Northern Mexico:—

(Humboldt,<sup>1</sup> 1811). "The mountainous region called the Bolson de

<sup>1</sup> *Essai politique sur la Nouv. Espagne*, Paris, 1811, 4to ed., vol. 1, pp. 282, 289.

Mapimi has an extent of more than 3,000 square leagues : it is from this district that the Apaches come to attack the colonies of Coahuila and New Biscay : the Bolson de Mapimi is sometimes regarded as unconquered, sometimes as forming part of the Province of New Biscay." "On the north and east of the Province of New Biscay is a strip of uncultivated country, 200 leagues in length, inhabited by Indian warriors and Independents. The border-forts erected for the defence of the colonists are too far apart, and the Indians are much dreaded."

(Ruxton,<sup>1</sup> 1846). "In the fall of last year, and at the present moment (1846), the Indians have been more audacious than ever was known in previous years."

"The ranchos and haciendas in Durango and Chihuahua are each enclosed by a high wall, flanked at the corners by circular bastions loopholed for musketry. The entrance is by a large gate which is closed at night ; and on the flat roof of the building, a sentry is constantly posted, day and night." "Between Mapimi and Chihuahua is a large unpeopled tract of country : it once possessed several thriving villages and ranchos, now deserted and in ruins. A road from Mapimi, disused for years and overgrown with grass, leads to Chihuahua through these deserted villages."

(Bartlett,<sup>2</sup> 1852). "The Apaches had been more bold than usual during the spring and summer of 1852, and the whole frontier had suffered from their inroads. Many men had been killed within a few miles of El Paso del Norte, and at the astronomical observatory, 8 miles distant, a man was pierced with arrows while herding the animals within a few rods of the house. No one could venture alone with safety 3 miles from the settlement (El Paso)." "The Comanches pass across the Rio Grande into Mexico in bands of three or four hundred, and penetrate the very heart of Chihuahua ; they have passed into Durango and Zacatecas, and have traversed Coahuila and Nuevo Leon. The extent of the depredations and murders committed by them would be appalling, if summed up. The depredations of the Apaches are less serious only because their numbers are less, and they have a more thinly settled country for their operations. These regions, once inhabited by a peaceful and happy population, are now deserted, and the fertile valleys they tilled are reverting to the condition of a wilderness." "The range of the

<sup>1</sup> *Advent. in Mexico and the Rocky Mountains*, by G. F. Ruxton, new ed., 1861, pp. 102, 111, 124.

<sup>2</sup> *Personal Narrative of Explor. in Texas, New Mexico, California, Sonora and Chihuahua*, New York, 1854, vol. 2, pp. 384-6, 396, 455.

Comanches is from the Mexican States alluded to, to the buffalo region, north and east of Santa Fé. In the fall and winter season their home is near the Rio Grande, in the Bolson de Mapimi, a vast basin shut in by mountains on the west." "Every small party coming through (to El Paso) from San Antonio had been attacked by the Comanches. At no time had so much alarm been felt." "The Bolson de Mapimi being now (November 1852) in possession of the Comanches and Lipans, who are some thousands strong, it is not considered safe for parties of less than one or two hundred to attempt the journey from Huejuquilla to Parras by the short route across its south-western corner."

In the decade 1860-70 portions of the frontier were still disturbed by Indian hostility.<sup>1</sup>

Under the above circumstances it is obvious that no evidence of wide and plentiful distribution of meteoritic masses in Northern Mexico has ever been available: any inference as to the occurrence of wide-spread falls must have been made merely from the presence of similar masses in a few widely separated localities.

#### 4. *Is the climate favourable to the preservation of meteoritic masses?*

Like the Desert of Atacama, Mexico is a table-land, but still more lofty and extensive: the table-land gradually slopes downwards in a northerly direction, the capital being 7,600 feet, Durango 6,630 feet, Chihuahua 4,600 feet, and El Paso del Norte 3,800 feet, above the sea-level. Hence the air is exceedingly dry, and the climate unusually favourable to the preservation of meteoric iron. Ward<sup>2</sup> says:—"With a cloudless sky and a brilliantly pure atmosphere, there is a great want of moisture and little luxuriance of vegetation."

In the discussion of the Atacama meteorites, it was proved that even in the still drier atmosphere of that region, meteoric stones could only escape disintegration for a very limited interval of time.

#### 5. *Are any of the falls of remote date?*

It will be shown that the history of some of the Mexican masses goes back to very distant times. One was found in an old tomb in the ruins at Casas Grandes: it was wrapped in the same kind of cloth as envelops the bodies found in the adjacent tombs, and must have been buried there

<sup>1</sup> *Encyclop. Britann.*, 1888, vol. 23, p. 820.

<sup>2</sup> *Mexico*, by H. G. Ward, Esq., Her Majesty's Chargé d'Affaires in that country during 1825-7, 2nd ed., London, 1829, vol. 1, p. 8.



before Mexico was conquered by the Spaniards. In the cleft of another mass is to be seen an ancient chisel of "copper," the material used by the Aztecs for their arms, axes, and tools in general. Two small worked specimens, belonging to the Aztec period and made of meteoric iron, are exhibited in the Museum of Mexico.<sup>1</sup> At least one of the masses in the south of Chihuahua was known long before the latter part of the sixteenth century. Those in the Valley of Toluca were visited about 1776. The mass called Descubridora was found before 1780: that of Zacatecas was examined in 1792: that of Charcas was described in 1804.

It is quite possible that with the exception of the small piece which fell at Mazapil in 1885, not a single one of the Mexican iron masses has fallen since the Spaniards obtained possession of the country. The masses thus seem to be nearly permanent in their material, and may have been lying for any number of centuries in the places where they have been found.

#### 6. *Transportation of masses.*

Some of the masses have been first noticed by scientific men after the removal from their place of fall. The mass already referred to as found in a tomb at Casas Grandes was clearly not *in situ*: according to one account, it is lenticular in shape and 18 inches in diameter; according to a later account its weight is such that 26 yoke of oxen were used to haul it to the village. The masses met with at Saltillo, Potosi and Cerralvo, were discovered in forges in use as anvils: the large masses of San Gregorio, Concepcion, Descubridora, Charcas, Zacatecas and Yanhuitlan, are all known to have been moved more than once, and for considerable distances. The possibility of similar removals in times prior to the conquest of Mexico by the Spaniards cannot be entirely disregarded.

#### 7. *Mechanical skill of the ancient Mexicans.*

The following extracts<sup>2</sup> are of interest as proving that before the arrival of the Spaniards there existed, in some parts of Mexico, men capable of moving immense blocks of heavy material when required.

"An immense circular block of carved stone was disinterred in 1790 in the great square of Mexico. This colossal fragment, on which the calendar is engraved, shows that they had the means of settling

<sup>1</sup> *Anales del Museo Nacional de México*, 1882, vol. 2, p. 473.

<sup>2</sup> *History of the Conquest of Mexico*, by W. H. Prescott, London, 1878, pp. 58, 68, 194, 233.

the hours of the day with precision, the periods of the solstices and of the equinoxes, and that of the transit across the zenith of Mexico." "It consists of dark porphyry, and in its original dimensions is computed to have weighed nearly fifty tons. It was transported from the mountains beyond Lake Chalco, a distance of many leagues, over a broken country intersected by water-courses and canals. In crossing a bridge, which traversed one of these latter in the capital, the supports gave way, and the huge mass was precipitated into the water, whence it was with difficulty recovered. The fact that so enormous a fragment of porphyry could be thus safely carried for leagues in the face of such obstacles, and without the aid of cattle, for the Aztecs had no animals of draught, suggests to us no mean ideas of their mechanical skill and of their machinery, and implies a degree of cultivation little inferior to that demanded for the geometrical and astronomical science displayed in the inscriptions on this very stone."

This remarkable stone, which had been buried by the Archbishop of Mexico (1551-9), is now preserved in their National Museum: its weight is estimated at 482 quintals or about 24 tons. We may incidentally remark that Alfredo Chavero<sup>1</sup> in a long series of papers has lately published the results of a most elaborate study of the hieroglyphs upon the stone: he comes to the conclusion that it cannot have been a calendar-stone at all, and was more probably a votive offering to the Sun.

And again—"The fortification was a stone-wall, nine feet in height and twenty in thickness, with a parapet a foot and a half broad. It extended more than two leagues. The work was built of immense blocks of stone, nicely laid together without cement; and the remains still existing, among which are rocks of the whole breadth of the rampart, fully attest its solidity and size. This singular structure marked the limits of Tlascala, and was intended as a barrier against the Mexican invasions."

The pyramid of Cholula may be cited as another illustration of mechanical skill:—"The perpendicular height is 177 feet; the base is 1,423 feet long; it is square and covers about 44 acres: the platform on the truncated summit is more than an acre in area: on the platform stood a sumptuous temple. Travellers still gaze with admiration on it as the most colossal fabric in New Spain."

Humboldt,<sup>2</sup> who gives a figure representing its appearance in 1802, states that the pyramid was already built when the Aztecs reached that

<sup>1</sup> *Anales del Museo Nacional de México*, 1879, vol. 1, p. 353, 1880, vol. 2, p. 3 et seq.

<sup>2</sup> *Vue des Cordill. et Mon. d. Peup. indig. de l'Amér.*: Paris, 1810, p. 24.

part of Mexico (A.D. 1190): its construction was attributed by them to the most ancient time known to their tradition—that of the Toltecs, five centuries before. It is now an almost shapeless hill, with a church at the top.

Finally, we may cite the statement of Humboldt<sup>1</sup> relative to the ruins of Mitla:—"But what distinguishes the ruins of Mitla from all the other remains of Mexican architecture, is the series of six columns of porphyry, placed in the middle of a large hall and supporting the roof. These columns, almost the only ones found in the New Continent, show the infancy of art. They have neither pedestal nor capital. Their height is 5 metres; yet each is formed of a single mass of amphibolic porphyry. The *débris*, accumulated during centuries, conceals the columns to one-third of their height."

For such a people, a transportation of even the largest of the observed masses of meteoric iron would not have been impossible.

#### 8. Reverence for meteorites.

It is well known that in various parts of the Old World, meteorites have been regarded, from the earliest times even to our own day, as objects for reverence and worship. The same is true of the New World. As evidence of such veneration, it may be mentioned that in the Aztec creed the creation of mankind was associated with the fall of a body from the sky. Andrés de Olmos,<sup>2</sup> who went to Mexico immediately after the conquest and made a careful study of its languages and traditions, states that, notwithstanding the diversity of worship in different provinces, there was an almost universal belief that the goddess Citlalicue gave birth to a *tecpatl* which fell from the sky to the earth at a place called Chicomoztoc (Seven Caverns); that from the *tecpatl* came sixteen hundred gods and goddesses: and that, after a complaint to Citlalicue that there was no one to worship them, mankind was created for their service.

*Tecpatl* occurs frequently among the Aztec hieroglyphs, and is there used to indicate one of the days of the month: representations of the various hieroglyphs, including *tecpatl*, have been given by Manuel Orozco y Berra;<sup>3</sup> the hieroglyph *tecpatl* is a figure of the sharp stone which was used as a knife by the sacrificing priest.

<sup>1</sup> *Essai politique, &c.*, Paris, 1811, vol. 1, p. 264.

<sup>2</sup> *Monarquía Yndiana*, by Torquemada: Sevilla, 1615, vol. 2, pp. 81-2.

<sup>3</sup> *Anales del Museo Nacional de México*, 1880-2, vol. 2, p. 224.

According to Humboldt,<sup>1</sup> the companions of Cortes are said to have seen a meteorite at Cholula, which, enveloped in a cloud of fire, had fallen from the clouds upon the pyramid; and he adds that it had the shape of a toad. I have been unable to trace the original authority for his statement. Humboldt refers also to an ancient tradition of the Aztecs, recorded in a Vatican manuscript of Pedro de los Rios, that the building of the pyramid of Cholula had been begun by Xelhua in commemoration of a Great Flood, which only he and six brother-giants had survived: the gods angered by his audacity sent down fire from heaven, whereupon the building was discontinued and the edifice was dedicated to Quetzalcoatl, God of the Air.

Muñoz Lumbier<sup>2</sup> refers to the Cholula meteorite as having been placed on the summit of the pyramid for the purpose of worship.

It is possible that there has been a confusion of traditions relative to a lightning stroke and a meteoritic fall, and even that a "divine" stone has been assumed by a translator to be of celestial origin.

The respect of the ancient Mexicans for native iron, whether known to be of meteoric origin or not, is illustrated in the careful envelopment and burial of the large mass of iron at Casas Grandes. One of the large Chihuahua masses was believed by the Mexicans of the sixteenth century to have been deposited by their deity for use as a landmark. In other parts of North America, proofs of the same veneration are to be found: in an Indian mound in Oktibbeha County, Mississippi, during an excavation for Indian antiquities, a small piece, weighing  $5\frac{1}{4}$  ozs., was discovered in 1857;<sup>3</sup> this may have been buried merely as a personal relic, for several ear-ornaments and implements, made of meteoric iron, were found in the mounds of Little Miami Valley, Ohio, in 1883.<sup>4</sup> The Brazos mass, weighing 320 lbs., removed to San Antonio in 1836, had been long known to the Comanches. It had been set up as a *fetich*, or object of veneration, at a spot where several converging trails intersected: it was the custom of all who passed by to deposit upon it beads, arrow-heads, tobacco, and other articles as offerings: the Indians "revered it as foreign to the earth and coming from the Great Spirit."<sup>5</sup>

<sup>1</sup> *Vues des Cordillères et Monuments des Peuples indigènes de l'Amérique*, Paris, 1810, p. 32.

<sup>2</sup> *Los Aerólites de Chihuahua*, México, 1880, p. 6.

<sup>3</sup> *Amer. Jour. Sc.*, 1857, ser. 2, vol. 24, p. 293.

<sup>4</sup> *Ibid.*, 1887, ser. 3, vol. 33, p. 228.

<sup>5</sup> *Trans. Ac. Sc. of St. Louis*, 1857-60, vol. 1, p. 622. *Amer. Jour. Sc.*, 1884, ser. 3, vol. 28, p. 286.

The Iron Creek mass, weighing 386 lbs., removed about 1869, was also "greatly venerated by the Indians, who made offerings to it of beads, trinkets and knives, before setting out on hunting or warlike expeditions."<sup>1</sup>

Hence it would have been far from surprising if a religious and skilful people, like the Aztecs, had transported meteoritic masses from their original sites for the purpose of worship: the large blocks of stone on Salisbury Plain furnish a good example of the transportation of heavy masses for great distances by a still more ancient race.

*9-10. Natural or artificial dispersion of masses belonging to a single type.*

In very few cases is there any evidence at all of wide distribution of masses belonging to a single type. The large masses of San Gregorio, Concepcion and Chupaderos, all in Chihuahua, are very similar in their external characters, and probably belong to a single fall: the extreme separation is about 66 miles, but it will be proved that the two former masses have been transported for some distance to their present sites. Masses belonging to a single type, and probably the results of a single fall, have been brought from widely separated places in Coahuila and its neighbourhood; masses belonging to another type have been brought from places in the Valley of Toluca and also at considerable distances therefrom: there is very strong evidence, however, that in these two cases the dispersion has been artificial. In the remaining cases there is nothing suggestive of wide-spread showers.

Tucson, though formerly within the Mexican border, is now in the United States: but the view has been expressed that the masses of iron, long preserved there, are products of a meteor to which various Mexican masses have been supposed to be due. The history and description of the Tucson masses, as already given in a separate paper,<sup>2</sup> are however sufficient to establish the complete independence of the Tucson and Mexican falls.

The history and distribution of the various Mexican masses are given below: it has been necessary to enter into considerable detail, for it will be seen that the identity of a mass, referred to in a given description, can often be established only by attention to some point which in itself is of merely trivial import.

*History and distribution of the Mexican meteoritic masses.*

In the value of his contributions to a general scientific knowledge of

<sup>1</sup> *Proc. & Trans. Roy. Soc. of Canada*, 1887, vol. 4, sec. 3, p. 97.

<sup>2</sup> *Mineralogical Magazine*, 1890, vol. 9, p. 16.

Mexico, Burkart takes a place next to Humboldt; in particular, his repeated inquiries after Mexican meteorites have had for their result a large addition to our information.<sup>1</sup> Lately Antonio del Castillo, Director of the School of Mines of Mexico, has done a great service, by placing on record a list of the meteoritic masses known to still exist in that country.<sup>2</sup>

It will be convenient here to indicate some of the conclusions, to which we are incidentally led by the following detailed investigation :—

1. The “Durango” mass, mentioned by Humboldt, inquired after for years by Burkart, and vainly searched for by many people in the course of the century, is undoubtedly identical with one of the Chihuahua masses at present known.

2. The “Durango” mass of Karawinsky was found at the Labor de Guadalupe, a few leagues from Durango City.

3. The “Venagas” mass, mentioned by Lawrence Smith in 1854, but up to the present untraced, is certainly identical with the Descubridora mass.

4. The mass supposed to be near Los Zapotes is identical with that of Zacatecas.

5. The so-called Chalco and Cholula masses are identical with that of Yanhuitlan; and the Misteca fragments are undoubtedly parts of the same.

6. The identity of the locality of the Coahuila masses mentioned by Shepard with that of the masses collected by Butcher, long suspected, is beyond doubt.

7. The situation of the so-called “Sancha Estate” is now determined.

8. The Rio Florido mass is probably identical with that of Concepcion.

We now proceed to the detailed discussion of the meteoritic masses found in the several States.

#### I. STATES OF COAHUILA AND NUEVO LEON.

The known meteoric irons of Coahuila may be grouped as follows:—

1. The masses which Shepard designated by the name *Bonanza*;
2. The masses collected by *Dr. Butcher*;
3. Masses brought from *Santa Rosa (de Muzquiz)*, but of which the previous history is matter of inference;
4. The *Sanchez Estate* mass.

With the above must be considered

<sup>1</sup> *Neues Jahrb. f. Mineralogie*, 1856, p. 257; 1857, p. 53; 1858, p. 769; 1866, p. 401; 1870, p. 673; 1871, p. 851; 1874, p. 22.

<sup>2</sup> *Catalogue Descriptif des Météorites du Mexique*, Paris, 1889.

5. The *Fort Duncan* mass (from the Texas side of the Rio Grande) :  
and conveniently also
6. The *Potosi* mass (Nuevo Leon), and
7. The *Cerralvo* mass (Nuevo Leon).

It will be sought to prove that all the masses belong to a single fall, have been brought to Santa Rosa from a district of small area in the Bolson de Mapimi, and have been artificially distributed, chiefly for the use of blacksmiths.

*Physical features of the Bolson de Mapimi.*

The Coahuila masses have been found in the Bolson de Mapimi, which, as already shown, was long frequented by the Apaches, Comanches and Lipans. The name was formerly given to a large extent of country bounded on the north by the Rio Grande, and having the towns of Huejuquilla, Mapimi and Santa Rosa, on its western, southern and eastern borders, respectively. The following description by Wislizenus will give some idea of its general features as seen from the southern base:—<sup>1</sup>

“Leaving Mapimi our road now led to a very open and level valley, which belongs to the famous Bolson de Mapimi which commences here. To the right of our road, or east, at the distance of from 3 to 5 miles a steep and high mountain-chain of limestone rises, and another chain to our left from 10 to 15 miles. Both chains gradually diverge, but especially the eastern which seems to run towards the north-east and to return thence towards the south-west at an angle, leaving a large *cul de sac* or pouch (Bolson) in the middle, from which form the country has probably received its name. The pouch-like slope of the country extends most likely as far as the Rio Grande. Passing over a ridge on our road, I enjoyed the most distant view over the Bolson de Mapimi. All around us was an immense chaparral plain, and in the distance of from 15 to 20 miles ahead of us the Rio Nasas, which runs towards the north into the above mentioned pouch, and forms there the large Laguna de Tlagonalila (on maps generally called Lake Cayman). Neither the lake nor the northern end of the Bolson was to be seen from my place of observation ; but the outlines of the surrounding mountains, disappearing on the most distant horizon, seemed to extend towards the north to about 80 miles in length, and towards east and west to an average breadth of 30 miles. As to the physical properties of the Bolson, the general impression is that it represents a low, flat, swampy country, and a mere desert, which

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<sup>1</sup> *Memoir of a tour to Northern Mexico, connected with Col. Doniphan's Expedition in 1846-7.* [Senate Doc.], Washington, 1848, p. 67.

is but partly true. The soil in the Bolson is less sandy, and better than in the higher country; in the valley of the Nasas, especially, is a black rich soil and most luxuriant vegetation. At Mapimi the elevation was found to be 4,487 feet, at San Sebastian 3,785, at San Lorenzo 3,815, at San Juan 3,775, at El Pozo 3,990, and at Parras 4,987."

*1-5. The masses probably belong to a single fall.*

The probable singleness of the fall is established by the unity of the rare characters of the masses. When a polished face of a Coahuila iron is etched, the Widmanstätten figures, so common in meteoric irons, are found to be everywhere, or almost everywhere, completely absent: in their place are seen the far less frequent systems of fine and straight parallel lines (called Neumann lines) extending across the etched face; the angles between the different systems, of course, varying with the direction of the section. The etched faces of specimens of the Sanchez Estate, Bonanza, Butcher and Fort Duncan irons, now in the British Museum, are indistinguishable in their features.

Looking to the rarity of such features on the etched faces of meteorites; and to the fact that the above masses have been brought from a region of the earth's surface comparatively small in area; and remembering that no mass belonging to the more common meteoritic type has yet been brought from Coahuila, while none, or at most one, belonging to the Coahuila type have been brought from any other part of Mexico; it is impossible to escape the conclusion that probably all have fallen simultaneously, whether the fall was wide-spread or not.

After investigation of the modes of fracture of meteoric iron, Huntington<sup>1</sup> came to the conclusion that, notwithstanding the similarity of the etched faces, the differences of fracture were such that it was impossible to regard the Sanchez Estate block and those collected by Dr. Butcher as ever having belonged to a single original mass: hence he assigned the Butcher irons to one fall and the Sanchez Estate to another, expressing the view that the latter was a wide-spread one, and was further represented by the mass found at Fort Duncan, and by others found hundreds of miles farther away, at Allen County in Kentucky, and Chattooga County in Georgia. Later observation, however, has shown that the variation of crystalline character in different parts of one block is quite sufficient to prove that the fracture is a discriminating character to which little weight can be attached.

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<sup>1</sup> *Proc. Amer. Acad. of Arts and Sciences*, 1888-9, vol. 24, pp. 34, 313.



### 1-3. The Bonanza, Butcher, and Santa Rosa masses.

*The localities of the Bonanza and Butcher masses are identical.*

The accounts given relative to the localities of the Bonanza and Butcher masses differ so much from one another that, without a minute comparison of the various statements, a decisive conclusion as to the identity or otherwise of the two localities is impossible: the difficulty is not diminished by the puzzling fact that in none of his papers does the later author make the slightest reference to the descriptions given by the earlier one in the same periodical, although the later expedition was probably a direct result of the account of the earlier visit. As previous discussion has left the identity of the localities uncertain, it is desirable to enter into such detail as will suffice to establish the identity in a decisive manner.

The masses referred to in Charles Upham Shepard's papers<sup>1</sup> had been visited by Major E. M. Hamilton: Shepard's statements are founded, partly on a letter from Professor Forrest Shepherd, who had been recently travelling with Hamilton in Nuevo Leon, and partly on later information derived directly from Major Hamilton himself; Lawrence Smith's accounts<sup>2</sup> are based on descriptions furnished by Dr. H. B. Butcher, who had himself collected several masses, and had transported them to the United States.

The differences in the accounts are in respect of (a) the number and sizes of the masses existent at the localities, (b) the distance of the localities from Santa Rosa.

#### (a.) *Number and sizes of the masses.*

1. *The Bonanza masses*:—"In an open space, about one quarter of a mile square, partially overgrown with palmetto palms, might be seen fourteen ponderous masses of native iron, the largest of which rises upwards of four feet above the ground, having the form of a bee-hive — being five feet in diameter where it enters the soil, and into which it descends for an unknown depth. Major Hamilton informed me that he excavated on one of its sides to the distance of 18 inches, without discovering any diminution of its diameter" (Shepherd's letter to Shepard, 1866). "Major Hamilton saw thirteen pieces; twelve of which had never been removed, and one small mass of about seventy-five pounds that had been carried to the village of Santa Rosa. The largest mass

<sup>1</sup> *Amer. Jour. Sc.*, 1866, ser. 2, vol. 42, p. 347; 1867, ser. 2, vol. 43, p. 384.

<sup>2</sup> *Ibid.*, 1869, ser. 2, vol. 47, p. 383; 1876, ser. 3, vol. 12, p. 107.

projects two or two and a half feet above the ground, and is some three feet long and a little less in width. How far it is buried in the earth is unknown. Some of the smaller of them are estimated to weigh between 2 and 3 thousand pounds." (Hamilton's letter to Shepard, 1867.)

2. *The Butcher masses* :—" I have returned fully successful, and am making preparations to send on the iron. They consist of eight pieces, varying from 290 lbs., which is the smallest, to 654 lbs., which is the largest, making a total of nearly 4,000 lbs. Before the explosion, the weight must have been much greater, as it is not probable that I have secured the whole, and we know some was taken away by the Indians, who thought they found large masses of silver, and carried their specimens to Santa Rosa." (Dr. Butcher, 1868.)

It is difficult to believe that the masses collected by Butcher, varying in weight between 290 and 654 lbs., can have been identical with any of those estimated by Hamilton to weigh at least 2 or 3 thousand pounds. As Butcher remarks, it is improbable that he secured all the specimens; and indeed it would be easy for some to have escaped attention. Hamilton himself says that the masses were distributed over an area between one and two miles in diameter: in Shepherd's version of Hamilton's statement, the space is stated to be a quarter of a mile square. Butcher says :—" The plain in many places is cut up with deep ravines; several of the specimens of iron were found among the stones and sand at the bottom of the ravines, and during heavy rains were washed or covered with water. It is, however, only in wet seasons that the water is found remaining in the ravines and depressions of the valley."

The differences in these statements of the number and sizes of the masses, though unsatisfactory, are not themselves sufficient to prove that the localities mentioned by Hamilton and Butcher are distinct.

(b.) *Distances from Santa Rosa.*

Shepherd gives a diagram in illustration of Hamilton's route, and the following distances :—" From Santa Rosa westerly to Nacimiento (*i.e.* Nacimiento) 40 miles, more or less. From Nacimiento westerly or north-westerly about 15 miles to a gap through the mountains called Puerta Santana (*i.e.* Puerto Santa Ana). From the Puerta, northerly for 60 miles, along the valley, past a spring to the termination of the mountain on the left; and thence around the end of the mountain, passing a second spring, by a north-west route for a distance of about 50 miles towards an apparent junction of the mountains."

This makes the distance from Santa Rosa to be 165 miles. On the

other hand, Butcher estimated the locality visited by himself as about 90 miles from the town.

The difference is, however, quite explicable as due to error of estimation. On what appears to be an excellent map, published by Garcia Cubas, the distance from Santa Rosa to Nacimiento is shown as 22 miles (instead of "40 miles more or less"); while the distance from Nacimiento to Puerto Santa Ana is given to be much less than 15 miles: hence it is clear that the estimated distances given in Shepherd's letter are of little value in establishing a difference of the localities.

Indeed, the indirect and direct statements made to Shepard are themselves very different; for according to the latter, apparently published as a correction of the former, the place was "about thirty or forty miles north of Santa Rosa, but much farther to the west," a statement very difficult to interpret.

(c.) *Direction from Santa Rosa : features of the locality.*

Both Hamilton and Butcher travelled into the mountains in a direction north-west of Santa Rosa; and their descriptions of the physical features of the locality itself are almost identical.

(*Shepherd.*) "And thence Major Hamilton travelled along the valley towards an apparent junction of the mountains; and where the valley becomes narrow, to an open space, about one quarter of a mile square, partially overgrown by palmetto palms."

(*Butcher.*) "The spot is in an alluvial valley, or plain, between two ranges of high mountains running parallel with each other, varying in distance from one to three miles."

(d.) *Hamilton and Butcher were not original discoverers.*

The existence of masses of iron about 90 miles north-west of Santa Rosa had long been known at that town.

"Meteoric iron is known to exist about 90 miles north-west of Santa Rosa. An American resident of this town, Dr. John Long, called my attention to a piece weighing some 25 lbs. which was then in possession of a Mexican. It is said that the whole surface of the area, embracing about 30 acres of land, where the deposition of this valuable mineral occurs, is covered with blocks of it, of greater or less extent, some containing as much or even more than 36 cubic feet." (Arthur Schott, 1857.)<sup>1</sup>

"According to an oral statement of Professor Posselt, meteoric iron

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<sup>1</sup> *Report on the U.S. and Mex. Bound. Survey* (W. H. Emory), 1857, vol. 1, part 2, p. 34.

exists in the vicinity of Santa Rosa : it is partly in large blocks, partly among the rolled stones, over a considerable area." (Wichelhaus, 1863.)<sup>1</sup>

The fragment analysed by Wichelhaus was taken from a specimen which had been placed in the Heidelberg Collection : the mass must have been a very small one, for there are now only 293·6 grams of Santa Rosa iron preserved there.

"Dr. John A. Veatch saw in 1849 a large mass of iron at Santa Rosa, which was then in use as an anvil at a blacksmith's shop, and was informed that many pieces of native iron had been used there for various purposes. The mass which Dr. Veatch saw was of about the size of an ordinary anvil. It was said to have been brought from the mountains north-west of the town." (Letter to Prof. Whitney, 1866.)<sup>2</sup>

"Residents in the vicinity told Major Hamilton (1867) it had only once before been visited by any traveller, and this was fifteen years ago, when an Englishman had been deputed thither, in an official capacity, to determine whether the iron could be applied to any useful purpose." (Shepard, 1867.)

"According to a son of Dr. Long, shortly after 1837 an Indian brought a piece, weighing 10 or 12 lbs., into Santa Rosa, supposing it to be silver, having found it some 90 miles north-west of the town." (Butcher, 1868.)

The following is clearly another account of the same incident:—

"One of my guides relates as a fact that at that time (1837) a Lipan Indian was riding one of their small ponies through the valley, when his stirrup struck against one of the masses, causing a ringing sound like silver. He dismounted, and was confirmed in his opinion of silver, and took away a piece, 10 or 12 lbs. in weight, which he carried into Santa Rosa to sell." (Butcher, 1868.)

(e.) *Hamilton and Butcher were guided to the same place.*

Hamilton and Butcher both started from Santa Rosa : they went with the specific intention of seeing masses, the existence of which had long been a matter of common report in that town : Butcher, at least, hired guides at Santa Rosa : both entered the mountains in a north-westerly direction. It is unlikely that more than one route through so dangerous a region can have been known to the inhabitants of Santa Rosa at that date ; and it would probably be the most natural route, and therefore the one used

<sup>1</sup> *Pogg. Ann.*, 1863, vol. 118, p. 631.

<sup>2</sup> *Proc. Calif. Ac. Nat. Sc.*, 1866, vol. 3, part 3, p. 241.

by the Indians themselves. Further, it is improbable that the inhabitants of Santa Rosa were so venturesome as to depart far from this natural route for the purpose of exploring the Bolson.

In fact, both Hamilton and Butcher seem to suggest that the place was reached by keeping along a particular valley, and Dr. Butcher says distinctly that it was near the regular Indian trail :—" I hired eight Mexicans and two Indians as guides, and started into the mountains, which are distant about 35 miles, and found the iron about 90 miles from Santa Rosa. As no vehicle could be got into the mountains by the route we entered, I spent two days in exploring a new road whereby the ox-teams could bring them out. My party were in considerable danger while in the mountains, as we were two miles from the regular trail, when some 300 Indians went through with a large number of their stolen horses."

*Passages of the Río Grande in this district.*

A route having the characters described by Hamilton and Butcher has every claim to be regarded as a natural one, and would lead to places where the Río Grande is known to be fordable ; and between Presidio del Norte and Eagle Pass not many parts of the Río Grande, to which the trail doubtless led, could be readily crossed by the Indian bands.

Lieutenant Michler,<sup>1</sup> who surveyed this part of the river, reports as follows :—

"From this valley (in the vicinity of Fort Leaton, near Presidio del Norte), we suddenly enter the range of the Bofecillos Mountains, through which the river has found or forced a passage, forming extensive rapids at its entrance. The cañon of the Bofecillos Mountains is less rugged in its character than those met with subsequently. Comanche Pass, the most celebrated and frequently used crossing place of the Indians, was found to be just below this Bofecillos Range : here broad, well-beaten trails, lead to the river from both sides. Below the crossing, the river passes through a country varying but little from that which was met with above. The San Carlos Mountains rise in front to a considerable height. The passage of the river through these mountains is grand and imposing. From the edge of the cañon the river may be seen far below, at a distance so great as to reduce it in appearance to a mere thread ; and from this height the roar of the rapids and falls is scarcely perceptible. The stream is hemmed in by the cañon for ten miles, and then leaves it with the same

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<sup>1</sup> *Rep. on the U.S. and Mex. Bound. Sur.* (W. H. Emory), 1857, vol. 1, part 1, p. 80, *et seq.*

abruptness that marks its entrance. As the descent of the river by boats was here impracticable, a *détour* was rendered necessary, and the river was again reached at a point some twenty miles below the lower termination of the cañon. It was here found necessary to cross the mule-train from the Mexican side: this was effected, though with considerable difficulty, at one of the usual crossings of the Indians. Near this point, above and below, the country is more open. After passing the Los Chisos Mountains, the survey was carried on with less labour than was previously encountered until we reached the Sierra San Vicente. Through these mountains the river forces its way, forming a cañon that equals the San Carlos in many places both in ruggedness and grandeur. Some sixty feet above the level of the river-bottom is situated the old Presidio San Vicente, long since abandoned and now crumbling to decay. After the Sierra San Vicente was found a country cut up with deep *arroyos*, presenting to the survey almost insurmountable obstacles. Passing these *arroyos* a wild valley, nearly at right angles with the course of the river, preceded the approach to the cañon of Sierra Carmel (Cármén), another of those rocky dungeons in which the Rio Grande is for a time imprisoned. No description can give an idea of the grandeur of the scenery through these mountains. Beyond the Sierra Carmel, the river seemed to pass through an almost interminable succession of mountains: cañon succeeded cañon: the valleys, which alone had afforded some slight chances for rest and refreshment, had become so narrow and devoid of vegetation that it was quite a task to find grass sufficient for the mules." "It was next to an impossibility to approach the river for the next twenty miles of the survey, this section being literally cut up by deep *arroyos*; steep hills, covered with rocks of igneous origin, intervene and jut into the water's edge. From the end of this section the country undergoes a great change: the formation is limestone, and the river forces its way through a deep cañon nearly twenty miles in length, its banks being composed of high perpendicular masses of solid rock. *Arroyos* of the same structure, at many places, open into the river; in following its course we had frequently to make *détours* of 25 and 30 miles, in order to advance our work a few hundred feet. Then came the first break in the cañon, and the crossing being fordable, formed an accessible pass for the Indians into Mexico. This ford is known as the Lipan crossing, and the Lipans often visited us here. Afterwards the bed is narrow and hemmed in by continuous and perfect walls of natural masonry, varying from 50 to 300 feet in height. Not unfrequently we had to travel for miles without being able to find a spot on which to land."

*Other assumptions would be necessary.*

Finally, we may remark that, if the two localities are distinct, it is necessary to assume that, although both localities were known to guides at Santa Rosa, the guides to each locality had no idea that the locality known to them was distinct from that known to the guides to the other, for there is no record of two localities having been ever mentioned at the town; and further, that if the two places were on the same Indian trail, Hamilton was taken by the Santa Rosa guides past the vicinity of the Butcher masses, which, though smaller and fewer, were identical in general character with those he was going so far to see, and that not one of them was pointed out by a guide or attracted his own attention.

*The localities are identical.*

From this analysis of the statements it appears that only one conclusion can be arrived at—namely, that the masses visited by Hamilton and Butcher were in a single locality; and that the masses brought from time to time to Santa Rosa for sale, or to be worked in the smithies, had been got from the same limited area.

From Butcher's description, it would seem that the locality was near the place now marked in Garcia Cubas' map of Coahuila as the site of a rancho called *San José de las Piedras* (latitude 28° 42' N., longitude 99° 43' W. of Mexico City).

#### 4. The Sanchez Estate mass.

This mass, weighing 252 lbs., now in the Smithsonian Institution at Washington, was figured and described by Professor Lawrence Smith in 1854-5.<sup>1</sup> The mass had been taken to the United States by Lieutenant D. N. Couch (not Gouch), who made some explorations in Northern Mexico during the winter 1852-3<sup>2</sup>: he found the mass in use as an anvil at Saltillo: "it was said to have come from the Sancha Estate, some 50 or 60 miles from Santa Rosa: various accounts were given of the precise locality, but none seemed very satisfactory: it is stated that where this mass was found there are many others of enormous size." Genth also analysed a fragment of this mass, but under a misapprehension makes the mistake of saying that it had been brought from New Mexico:<sup>3</sup> probably the label had been inscribed *N. Mexico*.

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<sup>1</sup> *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160.

<sup>2</sup> *Smithsonian Report for 1854*, pp. 15, 86.

<sup>3</sup> *Ibid.*, p. 15; *Amer. Jour. Sc.*, 1854, ser. 2, vol. 17, p. 239.

We have pointed out above that Dr. Veatch had seen a mass of meteoric iron in use as an anvil at Santa Rosa in 1849; and that it was then known at Santa Rosa that masses of large size were to be got from the mountains northwest of the town. Saltillo is a town having now 26,000 inhabitants, and is more than a hundred miles south of Santa Rosa, which has a present population of 3,350.

*Cost of anvils in Northern Mexico.*

Before the introduction of railways, anvils and other heavy goods which needed to be imported, would cost large sums for carriage to places so difficult of access from the coast as the towns of Northern Mexico.

The difficulty of obtaining iron at places like Santa Rosa in the early part of the century, is well illustrated by the experience of Phillips, who required some cast-iron pipes for the pumping engines at Catorce, a place comparatively easy of access from Santa Rosa and Saltillo. There was only one route north of Jalapa by which a carriage could ascend to the table-land from the east coast, and that was by way of Monterey and Saltillo: by this route Phillips had conveyed the pumping engines themselves to Catorce, exactly twelve months being necessary for their transport from London. Unluckily, cast-iron pipes for use with the engines had been forgotten, and Phillips learned at Catorce that the nearest iron-foundry was at Cincinnati on the Mississippi. To get the pipes Phillips left Catorce for Cincinnati in November 1824, received there the last of the castings in May 1825, and spent from May 1825 to February and March 1826 in transporting them to Catorce.<sup>1</sup>

An anvil would thus be comparatively cheap in Northern Mexico, if the distance of transport could be reduced to two or three hundred miles; and we might expect that the blacksmiths within a considerable distance from Santa Rosa would be supplied from that town, so long as portable masses of meteoric iron were obtainable.

The carriage of a meteoritic anvil from Santa Rosa to the other towns of Northern Mexico would be a trivial matter, compared with the trouble and the danger from Indians incurred during the transport of the mass to Santa Rosa itself.

Again, the greater the distance from Santa Rosa to which the anvil was carried, the less accurately would the position of the original locality be known; the estimates of distance given by Hamilton are a sufficient proof that no stress can be laid on the difference between the "sixty

<sup>1</sup> *Mexico*, by H. G. Ward, 2nd ed., 1829, vol. 2, p. 417.



miles " stated at Saltillo and the " ninety miles " stated at Santa Rosa : while the statement that " where this mass was found there are many others of enormous size " distinctly points to the locality already known to the inhabitants of Santa Rosa.

*Situation of the Sanchez Estate.*

The only difficulty is suggested by the mention of what appears to be a precise definition of locality, namely " Sancha Estate." Burkart long ago pointed out that *Sancha* was not a Mexican name, and must certainly have been mentioned in mistake : he suggested the possibility of the correct name being *Sanchez* ; but no one has hitherto been able to discover to what the name *Sancha* or *Sanchez Estate* can have referred.

The following extracts suggest an interpretation :—

" San Lorenzo is a town of about 1,000 inhabitants. Most of the property belongs to Señor Sanchez, a rich Mexican, who received us well and seemed to be favourable to the Americans." (Wislizenus, 1846-7.)<sup>1</sup>  
 " Soon after leaving we saw through an opening in the hills on our left, about a mile distant, the hacienda of Patos. This place is the property of Don Jacobo Sanchez, and is said to be the finest in the State of Coahuila. This gentleman is said to be the owner of three quarters of the landed property in the State, including several large and valuable haciendas, well stocked with cattle, mules and horses. He has lost large numbers by the Indians ; and, I am told, has made a claim on the United States for a million and a half of dollars as an indemnification for these losses. The lands of Don Jacobo extend in a continuous line more than a hundred miles." (Bartlett, 1852.)<sup>2</sup>

Patos is 36 miles west of Saltillo : both Patos and San Lorenzo are on the highway between that town and Chihuahua City.

At the time of Couch's visit (1852-3), the Sanchez Estate would thus be well known at Saltillo ; and an inhabitant of that town might be pardoned for treating the term Sanchez Estate as synonymous with the State of Coahuila itself : even if the blacksmith had got the mass from someone employed on the Sanchez Estate, there would still remain the practical certainty that the individual was one who had business relations with Santa Rosa, a town through which passed considerable traffic between Saltillo and Texas, by way of Eagle Pass, on the Rio Grande.

It may thus be inferred with considerable approach to certainty that the

<sup>1</sup> *Lib. cit.*, p. 70.

<sup>2</sup> *Lib. cit.*, vol. 2, p. 492.

Sanchez Estate mass had originally been found in the locality afterwards visited and described by Hamilton and Butcher.

### 5. The Fort Duncan mass.

This mass, weighing  $97\frac{1}{4}$  lbs., was found in 1882 by Mr. Cusick while stationed at Fort Duncan, Texas; Fort Duncan is 140 miles east of the locality specified by Dr. Butcher. Cusick<sup>1</sup> says:—

“I was returning to the garrison from a short trip in the vicinity when I casually noticed a round-looking boulder that seemed to have a metallic appearance. I had it brought to the fort by one of the privates, who found the task not an easy one. The mass was on the land of a Mr. Wieste on an ancient terrace on the American side of the Rio Grande.”

Hidden, to whom we owe the description of the mass, regards it as representing a distinct fall, but Huntington,<sup>2</sup> pointing out the insufficiency of his reasons, holds that the mass is an outlying member of a wide-spread shower, of which the masses to the north-west of Santa Rosa formed part. No one can compare two large etched faces belonging to the Fort Duncan and Coahuila irons without concluding that the identity of character is complete, and that the rarity of the character points to a probable simultaneity of fall; but it by no means follows that the fall was naturally wide-spread. Masses belonging to the Coahuila fall have been known, as already explained, since 1837 or soon after, so that the Fort Duncan mass, if really due to the same meteor, must have already had a minimum terrestrial existence of nearly half a century before it was found by Cusick: it is portable, for the weight is comparatively small. We have seen that much larger masses were long ago dispersed from Santa Rosa to greater distances than Eagle Pass, though in the opposite direction, for use as anvils. Further, as already remarked, Santa Rosa was a town through which passed much traffic from the eastern side of the Mexican tableland to Texas: the Eagle Pass, where Fort Duncan is situated, was the place where the river was crossed.

It is not at all impossible that the Fort Duncan mass was carried across the river by Indians or Mexicans for sale or use in Texas; was acquired, and afterwards forgotten or thrown away, by a predecessor of Mr. Wieste; and eventually re-discovered by Cusick.

### (6 and 7.) The Nuevo Leon masses.

We have said that masses from the north-west of Santa Rosa may be

<sup>1</sup> *Amer. Jour. Sc.*, 1886, ser. 3, vol. 32, p. 304.

<sup>2</sup> *Ibid.*: 1887, ser. 3, vol. 33, p. 115.

looked for in the smithies for considerable distances round that town. In fact, two anvils of meteoric iron have been seen in Nuevo Leon, within easy reach of Saltillo: still they have not been scientifically examined, and may possibly not be identical in character with those of Coahuila.

The first was mentioned in 1856 to Shepard by McDermot,<sup>1</sup> who had seen an anvil of meteoric iron in use at Cerralvo, District of Oriente, Nuevo Leon, in 1847: he likened it in general appearance to the Orange River mass, which weighed three hundredweight, and was then under inspection by him. The carriage from Saltillo to Cerralvo would be downhill, and would present no practical difficulty.

The second was seen by Weidner at the hacienda of Potosi, District of Galeana, Nuevo Leon: he estimated it to weigh about 200 lbs., and said that the shape was that of a quadrangular pyramid: it was mentioned by him in 1870.<sup>2</sup> There is a highway between Saltillo and the hacienda of Potosi, and the distance is about 70 miles: Potosi is also within easy reach of Catorce where meteoric iron has likewise been found.

Both masses have since been lost sight of.

#### *The Santa Rosa meteor of 1837.*

Lawrence Smith<sup>3</sup> published the following detailed account of a meteor which had been observed at Santa Rosa in 1837:—

“In a letter dated September 8th, 1868, Dr. Butcher writes, from information received from the son of Dr. Long, who had resided many years at Santa Rosa, that in the fall of the year 1837 there appeared over the town a most brilliant meteor, having a north-west direction. He describes it as most beautiful, lighting up the whole horizon, with a trail of brilliant light following in its progress. Shortly after its disappearance among the distant mountains, they heard a rumbling sound, immediately followed by a tremendous explosion. From the report, he thought it fell and exploded as it reached the earth, somewhere between Santa Rosa and the mountains, a distance of some thirty-five miles; and the next day he started with friends to examine the route, hoping to find it. After two days' severe and rough riding they abandoned the search and returned to town. Shortly afterwards an Indian brought a piece (of meteoric iron) weighing ten or twelve pounds into Santa Rosa, supposing it to be silver,

<sup>1</sup> *Amer. Jour. Sc.*, 1856, ser. 2, vol. 21, p. 216.

<sup>2</sup> *Neues Jahrbuch für Min.*, 1871, p. 854; *Catalogue Descriptif des Météorites du Mexique*, par Castillo, Paris, 1889, p. 9.

<sup>3</sup> *Amer. Jour. Sci.*, 1869, ser. 2, vol. 47, p. 384.

having found it some ninety miles north-west of the town, being in the same direction in which Dr. Long and his friends had been exploring, the doctor having been deceived as to distance, he only going to the base of the mountains, instead of crossing it and then following the valley for some forty miles further."

Though Long's description points to a meteoritic fall at a place north-west of Santa Rosa, it cannot be legitimately assumed with Long and Butcher that the fall must be identical with that to which the meteoric iron found in a north-west direction from the town was due. If such identity could have been assumed, it would have sufficed to establish that the masses brought from Sanchez Estate, Fort Duncan, Potosi, and Cerralvo, were not parts of a wide-spread fall, but had been either transported to those places, or had belonged to distinct meteors.

*Chemical analyses of the Coahuila masses.*

The following results have been obtained on analysis of fragments of the Coahuila masses :—

	Sanchez Estate.		Near Santa Rosa.				Fort Duncan.	
	"New Mexico," Genth, <sup>1</sup> 1854. S.G. 8-130.		Smith, <sup>2</sup> 1854-5. S.G. 7-81.	Wichelhaus, <sup>3</sup> 1863. S.G. —.	"Bonanza Iron," Shepard, <sup>4</sup> 1867. S.G. 7-825.	"Butcher Iron," Smith, <sup>5</sup> 1869. S.G. 7-692.	Lupton, <sup>6</sup> 1885. S.G. —.	Mackintosh, <sup>7</sup> 1886. S.G. 7-522.
	I.	II.						
Iron ..	96.17	95.92	95.82	96.07	97.9	92.95	91.86	94.90
Nickel ..	3.07	3.57	3.18	3.26	2.1	6.62	7.42	4.87 by diff.
Cobalt ..	0.42		0.35	0.55		0.48	0.50	
Phosphorus ..	..	..	0.24	1.05		0.02	0.27	
Residue ..	..	0.57	..	..	..	..	..	
	99.66	100.06	99.59	100.93	100.00	100.07	100.05	100.00

Notwithstanding the numerical differences in the above results, Lawrence Smith was quite prepared to recognise the chemical identity of the Sanchez Estate and Butcher irons, and said (1869) that the separation of the iron and nickel in his analysis (1854-5) of the former was probably imperfect.

<sup>1</sup> *Amer. Jour. Sc.*, 1854, ser. 2, vol. 17, p. 239.

<sup>2</sup> *Ibid.*, 1855, ser. 2, vol. 19, p. 160.

<sup>3</sup> *Pogg. Ann.*, 1863, vol. 118, p. 631.

<sup>4</sup> *Amer. Jour. Sc.*, 1867, ser. 2, vol. 43, p. 385.

<sup>5</sup> *Ibid.* 1869, ser. 2, vol. 47, p. 383.

<sup>6</sup> *Ibid.* 1885, ser. 3, vol. 29, p. 232.

<sup>7</sup> *Ibid.*, 1886, ser. 3, vol. 32, p. 304.

*Literature relative to other characters of the Coahuila masses.*

In addition to the literature already cited we may mention the papers by Lawrence Smith, on the occurrence of daubréelite, *Amer. Jour. Sc.*, 1876, ser. 3, vol. 12, p. 107; and of a nodule of chromite, *Ibid.*, 1881, ser. 3, vol. 21, p. 461; and those of Brezina on the intergrowth of troilite and daubréelite, on the Reichenbach lamellæ, *Sitzungsber. Ak. d. Wiss. Wien*, 1881, vol. 83, div. 1, p. 476, and on natural planes of separation, *Ibid.*, 1882, vol. 84, div. 1, p. 282.

## II. STATE OF CHIHUAHUA.

The meteoric irons of Chihuahua, mentioned in literature, belong to one or other of the following:—

1. *The Casas Grandes mass.*
2. *A mass exhibited in 1876 at the United States International Exhibition.*
3. *The group between Presidio del Principe and Cuchillo Parado.*
4. *The group near Huejuquilla or Jimenez.*

## 1. The Casas Grandes mass.

Casas Grandes, or Casas Grandes de Malintzin, is the name given to an ancient town and fortress, which commanded the last passage from the North to the Mexican table-land: it is situated in the District of Galeana, and is 125 miles, in direct line, south-west of El Paso del Norte.

From the accounts given by Márcos de Niza, Coronado, Espejo and others, it is well established that at the time of the conquest of Mexico by the Spaniards, in the sixteenth century, the country was inhabited in the fertile valleys, to districts far north of Santa Fé, by Indians who had attained to a comparatively high degree of civilisation, were given to agriculture, were clothed with woven fabric, and lived in large towns consisting of houses which were several stories in height and were built of sun-dried brick. The Valley of Mexico itself is known to have been peopled from the North; and it has been supposed that extensive ruins, still existing between the Valley of Mexico and the country north of the Rio Grande, indicate places at which there were prolonged halts during the migration southwards.

One of these ancient relics is at Casas Grandes de Malintzin.

The first mention of the discovery of a mass of meteoric iron among the ruins at Casas Grandes was made by Tarayre,<sup>1</sup> who reported in 1867 as follows:—

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<sup>1</sup> *Archives de la Commission Scientifique du Mexique*, Paris, 1867, vol. 3, p. 248.

“ A very important discovery has been made in the great temple of Casas Grandes by Müller, the Director of the Mint of Chihuahua. An excavation, made in one of the chambers of the labyrinth, brought to light, at a small depth, a lenticular mass of meteoric iron, 50 centimetres in diameter, wrapped with care in cloths, similar to those which enshroud the ancient corpses in the tombs of the same locality. The neighbouring tombs are chambers built of masonry: the horizontal section being an ellipse with diameters of 1·5 and 1 metres, and the height 1 metre. In each case the body is seated on the base of the tomb, and has the knees raised: it is enveloped in cloth made of fibres, which recall those of the agave; and around it are deposited objects which belonged to the deceased when alive, such as necklaces, collars, bracelets, and pottery.”

Another account was given in 1873 by Mr. M. Pierson,<sup>1</sup> United States Vice-Consul at El Paso del Norte, from which the following is extracted:—

“ Some three or four years since, a party of the inhabitants of the town of Casas Grandes, as a matter of curious speculation, commenced excavating in the old ruins there. One more fortunate than the others drifted into a large room, in the middle of which there appeared a kind of tomb made of adobe-brick. Renewing his excavations, he found a large mass of meteoric iron in the middle of the tomb, carefully and curiously wrapped with a kind of coarse linen. Twenty-six yoke of oxen were mustered, and as many or more strong log-chains, and the meteorite was hauled to the town of Casas Grandes. It measures 2 feet 6 inches square, and is supposed to weigh 5,000 lbs.”

Until a more complete scientific examination of the Mexican meteorites has been made, it will be impossible to say from what locality this mass may have been transported by the ancient inhabitants of Casas Grandes.

The Casas Grandes mass has not been heard of since the date of Pierson's letter: on inquiry at El Paso, I learn that Pierson is now dead, and that there is no remembrance in that town of the circumstances recorded by him.

The description given by Pierson would not be inappropriate to the mass next mentioned.

## 2. A mass exhibited in 1876 at the United States International Exhibition.

An uncut block of meteoric iron, estimated to weigh about 4,000 lbs., is

<sup>1</sup> *Smithsonian Rep. for 1873*, p. 419.

preserved at Washington, in the United States National Museum. Dr. F. W. Clarke recalls that it was exhibited among the Mexican minerals in the United States International Exhibition of 1876, and was said to have been brought from the State of Chihuahua.<sup>1</sup> I am indebted to Dr. Clarke for a photograph showing at once this Chihuahua mass and the ring-shaped one from Tucson: by measurement of the photograph and comparison with the known dimensions of the latter mass, it follows that the former, a roundish block, is about 28 inches wide and 38 inches high.

Its history previous to 1876 is as yet untraced.

Professor Barcena, while at Philadelphia as Commissioner for the Mexican part of the Exhibition, read a paper before the Academy of Sciences relative to the Mexican Meteorites: he made no reference either to the Casas Grandes mass or to the one then being exhibited in Philadelphia, and this is difficult to account for unless the two masses were regarded by him as well known to be identical. Still it is unsafe to place much reliance on negative evidence, for no direct reference was made by him to the existence of the immense San Gregorio mass.

The mass cannot have belonged to the Presidio del Principe group; for, as will be seen below, the remarks of Professor Barcena implied that up to 1876 none of the group had been removed from the locality.

The only other large Mexican mass, mentioned in literature but now unaccounted for, is that of Rio Florido; but, as shown below, there are grave doubts as to whether the Rio Florido mass had ever a real existence as distinct from that of Concepcion.

### 3. The group between Presidio del Principe and Cuchillo Parado.

All that is known of this group is the following:—

Cornejo<sup>2</sup> (1869-70) says:—"A mass of meteoric iron was seen by José Salazar Ilarregui between Cuchillo Parado and Presidio del Principe: it attracted one pole of a magnet and repelled the other: in this place are numerous other masses of smaller size."

Mention was also made of them, in 1876, by Professor Mariano Barcena<sup>3</sup>:—

"Meteoric irons of various dimensions are found in the vicinity of the

<sup>1</sup> *U.S. Centennial Commission. International Exhibition, 1876. Reports and Awards.* 1889, Washington, vol. 3, group 1, p. 369.

<sup>2</sup> *La Naturaleza*, 1869-70, vol. 1, p. 256.

<sup>3</sup> *Proc. Ac. Nat. Sc. Philadelphia*, 1876, p. 122.

Presidio del Principe, in the State of Chihuahua : the inhabitants of that State have promised to send some of the masses to the city of Mexico.''

It may be observed that José Salazar Ilarregui (or Y Larregui) was in 1854 the Mexican Commissioner for the Survey of the United States and Mexican Boundary.<sup>1</sup>

Presidio del Principe is not shown in the latest maps ; but in older maps, for instance Humboldt's, it is placed 45 miles directly north of Chihuahua City, and thus in the same parallel of latitude as Cuchillo Parado, from which it is distant about 100 miles in a westerly direction.

#### 4. The Huejuquilla or Jimenez group.

We may incidentally mention that the iron of this group was known at the beginning of the present century as "Durango iron," and that one of the masses was described by Humboldt, through a misunderstanding of the term, as being near Durango City : this point will be established later.

Huejuquilla, the nearest town to the largest members of this group, is the capital of the District of Jimenez. According to Bartlett,<sup>2</sup> though the name of the town, as given on the maps, was already (1852) Jimenez (after the Mexican patriot of that name), the town was only spoken of in the neighbourhood by its old Indian title, pronounced as Wa-hu-ke-yah : in literature the word is met with in various forms, *e.g.* Huajuquillo, Huejoquillo, Huexuquilla, Huejuquilla, Hejuquilla, Haxuquilla, Guajuquilla and Guayuquilla. There is now at the town a station called Jimenez, belonging to the Mexican Central Railway, and the old name may possibly fall into disuse ; but as the old Indian title is used in all the references quoted in the present paper, it will be convenient to employ it throughout, and to select the form *Huejuquilla* adopted by the Mexican Postal Authorities.

The masses are the most wide-spread of any recognised group, and the wide dispersion is generally accepted as a natural one : the history of the masses thus requires minute consideration, if we are to get a reliable estimate of the maximum observed distance of dispersion for a single meteoritic fall.

The following, except that of Rio Florido, are known to still exist :—

- a. A large mass now at the hacienda of San Gregorio.
- b. A large mass now at the hacienda of Concepcion.
- c. A large mass said to have been seen many years since at Rio Florido.
- d. Two large masses now at the rancho or hacienda of Chupaderos.

<sup>1</sup> *Rep. on the U.S. and Mex. Bound. Survey* (W. H. Emory), 1857, vol. 1, part 1, p. 35.

<sup>2</sup> *Lib. cit.*, vol. 2, p. 453.



- e. A small fragment brought from Sierra Blanca.
- f. A small fragment brought from the rancho of Tule.

*Sizes of the above masses.*

	Length.	Breadth.	Height.	Estimated Weight.
	Metres.	Metres.	Metres.	Kilograms
Chupaderos (a) ...	2·5	2	0·4	15,600
„ (b) ...	2·15	1·1	0·5	9,290
Concepcion ...	1	1	0·4	3,130
San Gregorio {	Conical: diam. of base 1·2		1	11,560
Rio Florido ...	Said to be about half the size of Concepcion			
Sierra Blanca ...	Small fragment			
Tule ...	Small fragment			

From Chupaderos to San Gregorio in direct line is 66 miles : Tule is still more remote from Chupaderos being 42 miles farther away beyond San Gregorio.

*Do the masses belong to a single fall ?*

We know as yet very little of the figures produced by etching polished surfaces of these masses : the information, so far as it goes, is not unfavourable to the unity of the fall, for though a minute fragment of the Concepcion mass experimented upon is said to yield no Widmanstätten figures, while on the other hand the San Gregorio, Sierra Blanca and “ Durango ” fragments present a very definite octahedral structure,<sup>1</sup> it has been granted that a satisfactory specimen of the Concepcion mass has not yet been available for the purpose of scientific examination.

Large masses of meteoric iron are so rare, however, that it is difficult to believe that four of the largest masses of meteoric iron yet found on the earth’s surface can have fallen within this limited district at different times ; and the external appearances of the masses, as shown in the excellent photographs kindly sent me by Don Antonio del Castillo, are so very similar, owing to the presence of numerous enclosures of troilite, that the lingering doubt as to the singleness of the fall must disappear.

As pointed out later, the evidence relative to the small Tule fragment is of a very unsatisfactory character, and can be allowed little weight.

<sup>1</sup> *Beschreibung und Eintheilung der Meteoriten zu Berlin* (Rose) ; 1864, p. 64 : *Die Meteoriten-Sammlung in Wien* (Brezina) ; 1885, p. 71 : *Proc. Amer. Ac. of Arts and Sciences*, 1888, vol. 24, p. 35.

*The region near Huejuquilla, Concepcion and San Gregorio  
is favourable to transport.*

Ruxton<sup>1</sup> says:—"The first day's march from Durango led through a wild uncultivated country (1846), with large plains of excellent pasture, but not a symptom of cultivation." Two days later, his march was "to the rancho of Yerbaniz, through the same uncultivated plains, surrounded by sierras, and passing by a ridge from one into another, each being as like the other as twins. For a thousand miles the aspect of these plains never varied, and the sketch of the plain of Los Sauces would answer for the plain of El Paso, and every intermediate one between Durango and New Mexico." "The plains, generally 10 to 20 miles in width, are divided from each other by an elevated ridge, but there is no perceptible difference in the elevation of them from Chihuahua to El Paso. The road is level except in crossing these ridges."

Having regard to the mountainous character of the region on the west of the table-land, and the few crossing places on the Rio Grande, it is seen that the above route would be one naturally selected for the traffic between Mexico City and the provinces to the extreme north of New Spain. This traffic was already a large one at the beginning of the present century: Humboldt<sup>2</sup> says:—"Thousands of mules arrive every week at Mexico City from Chihuahua and Durango, carrying silver, leather, soap, a little wine from El Paso del Norte, and grain."

Between Rio Florido and Santa Rosalia, two places on this line of traffic, the usual route was by way of Concepcion, El Valle de San Bartolomé (or Allende), Santa Cruz, and Rio del Parral: another road, instead of passing through El Valle de San Bartolomé, went through Huejuquilla, but was less used. As the latter route was taken by Bartlett for his caravan, the two roads cannot have been very unequal as regards facility for transport: probably the former was generally taken as passing through the important town of El Valle. At the present time there is a cart-road between Chupaderos, Huejuquilla and El Valle. (Plate II.)

The country thus presents no obstacle to the transport of masses from the neighbourhood of Huejuquilla to either Concepcion or San Gregorio.

### A. The San Gregorio mass.

*The existence of native iron near Huejuquilla has long been known.*

Relative to the masses now at Chupaderos, Castillo in his list of existing

<sup>1</sup> *Lib. cit.*, pp. 108-9, 162.

<sup>2</sup> *Essai cit.*, vol. 2, p. 689.

Mexican meteorites writes as follows :—“According to the history of Philip II., the discovery was made in 1581 by the explorer Antonio de Espejo.” On investigation, however, it appears that only a single expedition was made by Espejo, and that he did not start off from El Valle de San Bartolomé till Nov. 10th, 1582 ; further, in the report of his expedition, he makes no mention of any masses of iron, and, as he followed the course of the river Conchos, it is unlikely that he was ever in the immediate neighbourhood of Chupaderos itself.<sup>1</sup>

As there appeared to be some mistake, the statement relied upon by Castillo was searched for in various histories, and at last found in the “Historia de Felipe Segundo, Rey de España,” by Luis Cabrera de Cordoba.<sup>2</sup> The following is a literal translation of the passage :—

“Francisco Vasquez Coronado was sent by the Viceroy, in the year 1544, with a large number of attendants and horses, and made a brief survey (of New Mexico) ; but not so Friar Márcos de Niza, who acted as guide, for he entered upon the conversion of the Indians so boldly that he was put to death, as was discovered afterwards. Up to the year 1581, no further attempt to conquer the region was made by the inhabitants of New Spain : Don Lorenzo Xuarez de Mendoza, Count of Coruña, the Viceroy, then made a beginning by sending Francisco Vasquez Chamuscado with soldiers and friars of the Franciscan Order : as the friars were unwilling to retire with the soldiers, and persisted in preaching, they were put to death by the barbarians. In this year Espejo, and afterwards Castaño, and Captain Francisco de Leiva Bonilla, went upon discovery without (the requisite) license : the last mentioned was followed for a hundred leagues by Captain Don Pedro de Cazorla, who at the time was acting as governor, and he was ordered not to enter New Mexico under penalty of being denounced as a traitor. So great was the desire that the King should permit this conquest to be made, that many knightly claimants offered their lives and estates with Christian zeal. \* \* \* By resolution of his Majesty, on the recommendation of the Viceroy, the commission was granted to Don Juan de Oñate with the title of Adelantado. \* \* \* They reached the farthest villages on the borders of New Biscay, where there is a tradition of the Indians that, when they were coming from New Mexico to people the Old, their deity in the form of an aged woman placed there a

<sup>1</sup> Hakluyt's *Collection of the Early Voyages, Travels and Discoveries of the English Nation*, London, new ed., 1810, vol. 3, p. 457.

<sup>2</sup> Madrid, 1619, lib. 13, p. 1163 : also *Edicion publicada de Real orden*, Madrid, 1876-7, vol. 2, p. 677.

remarkable landmark of seemingly more than 800 quintals (hundred-weight) of iron, whereupon some returned to their mother-country and the rest went on to people New Spain. And, for their boundary and peace, they were divided by this wondrous landmark, set up in a desert, in latitude  $27\frac{1}{2}$  degrees, as lustrous as refined silver. The Adelantado entered with 80 carts, many kinds of grain and seed, and splendid soldiers, some unmarried, and others married and with families: they marched with great toil, not knowing the proper roads to take; and at the end of seven months they reached the province they were making for."

According to the latest maps Huejuquilla is in latitude  $27^{\circ} 10'$ , so that there can be no doubt that one of the masses of the Huejuquilla group is here referred to.

Owing to the want of clearness of the above statement, it would be easy to make the wrong inference that the iron was discovered in the year 1581 by Espejo and Oñate.

#### *The Expedition of Espejo.*

A more precise account of the course of events, however, is the following, obtained from the report of Espejo's expedition published in 1586:—

Friar Agustin Ruiz, who was living at El Valle de San Bartolomé, having heard of the existence of other peoples farther north, set out in 1581 with two other friars and eight soldiers to convert the Indians: they reached the region since called New Mexico, and shortly afterwards one of the friars was put to death: the soldiers refused to go farther and decided to return; Ruiz and his companion, being unwilling to accompany them, were left behind. On the return of the soldiers to El Valle de San Bartolomé, the friars there were anxious to send relief to the two brethren left behind; and Espejo, a rich inhabitant of Mexico, and a native of Cordova, who happened to be then at the mines of Santa Barbola (*sic*) or Barbora (*sic*), agreed to take charge of the expedition: having obtained the requisite license, he set off on Nov. 10th, 1582, from El Valle de San Bartolomé "with 115 horses and mules, much arms and ammunition and some attendants." The friars had been put to death before the arrival of the expedition: Espejo eventually returned in July 1583, and an account of his journey was published at Madrid in 1586.

#### *The Expedition of Oñate.*

But the expedition made by Don Juan de Oñate was a totally different

one ; for he set forth, many years afterwards, not to inspect, but to obtain possession of and colonise the new province. According to a letter, written by Tribaldus Toletus<sup>1</sup> in 1605, Don Juan left Old Mexico "in the year 1599 with an armie and carriages of five thousand men, in which number boyes, women, young men and souldiers are included. He carried also great store of vituals with him, stockes of sheepe and goates, herdes of oxen, and all things necessarie for life, also horses and armour and other things which in these kinds of expeditions ought to be provided."

As we have already seen that Don Juan marched slowly and was seven months on his journey, his arrival at the iron-landmark, if the letter of Tribaldus Toletus be correct, may have been either in 1599 or 1600, and more probably in the latter year.

*Inscription on the Concepcion mass.*

If the great colonising expedition of Oñate had really passed the iron-landmark in the year 1600, it would have been probable that the landmark was really the Concepcion mass, and another possible explanation could have been given of some marks still visible on that iron.

Urquidi,<sup>2</sup> the owner of the hacienda of Concepcion, says (1871) :—

"Among the various marks, there is an inscription, made with some nicety and regularity, saying, "A. 1600."

Bartlett,<sup>3</sup> who saw the mass in 1852, says :—

"On the top, which is quite smooth, is an inscription bearing the date 1600 ; but I was unable to make out a single word of it, so much has it been defaced by hammering and the addition of many crosses. It is said that the inscription gave some account of the removal."

It has since been established, as shown later, that the Concepcion mass was transported a distance of many leagues to the vicinity of that hacienda on 29th April, 1780 : hence it is conceivable that the inscription might have been a commemoration, not of the removal, but of the passage of the specimen by the expedition of Oñate in the year 1600 : the "nicety and regularity" of the inscription are suggestive of the industry and careful workmanship so important an expedition would have had at its command : in any case the inscription was probably made before the

<sup>1</sup> *Purchas his Pilgrimes in five bookes, &c.*, London, 1625. Fourth part, The Eighth booke, chap. III., pp. 1565-7.

<sup>2</sup> *Boletín de la Sociedad Mexicana de Geog. y Estad.* Segunda época, México, 1871, vol. 3, p. 275.

<sup>3</sup> *Lib. cit.*, vol. 2, p. 457.

removal in 1780, otherwise the removal itself would not have been forgotten so soon as was actually the case.

Such a connection between the Concepcion mass and the expedition of Oñate has already, I find, been independently suggested by Muñoz Lumbier,<sup>1</sup> a copy of whose rare paper I owe to the kindness of Castillo : we shall see, however, that the suggestion, though apparently a natural one, is not well founded. The list of the Mexican meteorites was published by Castillo when at Paris far away from his own library : doubtless his reference to Espejo was a trick of memory, and he was intending to quote from the paper of his former pupil, Muñoz Lumbier, in which the extract from Luis Cabrera de Cordoba's History of Philip the Second is given.

*The date of Oñate's expedition.*

There is an extraordinary difficulty, however, in ascertaining the real date of departure of the colonising expedition of Don Juan de Oñate. Ludovicus Tribaldus Toletus, whose letter is dated so soon afterwards as 1605, gives the year 1599 on the basis of a manuscript volume of Andrew Garcia Cespedes, "who hath not obtained leave to publish it, for they will not have these things particularly to come to light." Luis Cabrera de Cordoba, also a contemporary (1559-1623), with access to important documents, though giving, as we have seen, minute details of the expedition, makes no mention of the year of its departure. According to the manuscripts of Padre Geronimo de Zarate Salmeron,<sup>2</sup> whose journal was made public in 1629, Don Juan de Oñate set out from Mexico City to New Mexico in 1596, and in 1599 started from New Mexico on an expedition farther north, in search of the reported city of Quivira. The years 1591, 1595, 1598, have also been accepted for the date of his departure from the City of Mexico. On the other hand, the petition of Don Juan to the King of Spain for permission to colonise New Mexico is said to have been dated as late as 21st September, 1595 : the decree of the King confirming the capitulation and agreement, made between the Viceroy and Don Juan, is dated San Lorenzo, 8th July, 1602 : the approval of this decree by the Royal Audience of New Spain was given in Mexico City on June 20th, 1604.<sup>3</sup>

It seems, on the whole, that Geronimo de Zarate Salmeron, who spent

<sup>1</sup> *Los Aerólitos de Chihuahua.* México, 1880.

<sup>2</sup> *Documentos para la Historia de México.* Tercera Serie. México, 1856, vol. 1, pp. 23-26.

<sup>3</sup> *The Spanish Conquest of New Mexico.* By W. W. H. Davis. Doylestown, Pa., 1869, p. 264.

eight years in New Mexico shortly after the colonisation, is most likely to be correct, and that the expedition of Oñate really left Mexico City in 1596. And although he doubtlessly kept up his communications with Old Mexico, and was followed by other companies of intended colonists, we can only infer, with safety, that whenever the inscription on the Concepcion mass was made, it was desired to commemorate the fact that the mass was at that time supposed to have been already known in the year 1600.

According to Manuel Orozco y Berra,<sup>1</sup> Don Juan de Oñate and his companions in New Mexico were so eager in their search for precious metals, that they neglected to construct a fort at San Gabriel, or to secure grain for the colonising force. Famine set in; and the colonists, disappointed in their expectations, seized the opportunity of Don Juan's absence on an exploring expedition to return to Santa Barbara in 1601. On his return to San Gabriel, Don Juan declared the absentees to be traitors, and condemned them to death: he set off towards Santa Barbara to give effect to his sentence, and reached there at the beginning of January 1602.

It is clear that about the year 1600 there was an extraordinary amount of traffic in the immediate neighbourhood of the masses of iron belonging to the Huejuquilla group.

*Another account of the landmark.*

Although, in his description of Oñate's expedition, Geronimo de Zarate Salmeron makes no reference to the iron-landmark, a search through his journal brings to light a statement, by which we are able to establish that neither a Chupaderos mass nor that of Concepcion is the one referred to in the above account. After mentioning other evidence that Old Mexico had been peopled in ancient times from the North, Zarate Salmeron proceeds as follows:<sup>2</sup>—

“There is also an old tradition among the Indians that a lump of metallic iron, which is three leagues distant from Santa Barbola (*sic*), and half a league away from the road along which the carts pass when going to New Mexico, is a memorial of the coming of the Mexicans to people this country (Old Mexico); and that they halted near there, and that the idol which used to speak with them told them that it would tarry at the place as a memorial. The iron must weigh upwards of 800 quintals, and they say

<sup>1</sup> *Apuntes para la Historia de la Geografía en México.* México, 1881, p. 183.

<sup>2</sup> *Documentos para la Historia de México.* Tercera Serie. México, 1856, vol. 1. pp. 47-8.

that a deity, in the form of an Indian woman, aged and wrinkled, used to draw it along. How remarkably strong the Indian old woman must have been ! It is an object which all who pass along this road go and look at as a curiosity. A blacksmith of Santa Barbola (*sic*) severed a bit from one side ; and others, not believing it to be an object which could have been moved and dragged from a distance, but suspecting it to be (the outcrop of) a mine of native iron, made an excavation beneath it : on the removal of the earth by which it was supported, the mass turned over on one side, and it is in that position at the present day."

This statement evidently refers to the mass mentioned in the History of Philip II. by Luis Cabrera de Cordoba. The two statements differ in character, and must have been made independently of each other, though recording the same Indian tradition : for the latter historian died in 1623,<sup>1</sup> and apparently was never in Mexico, while Geronimo de Zarate Salmeron's journal, preserved in Mexico City, was not ordered to be published till 1629.

To fix the position of the iron-landmark at the end of the sixteenth century we thus have two statements :—1st, that the site was on the route taken by Oñate to New Mexico, and in latitude  $27\frac{1}{2}^{\circ}$  north ; 2nd, that the mass was three leagues from Santa Barbola, and half a league from the highway to New Mexico.

*Santa Barbola is identical with Santa Barbara.*

In the description of the journey of Espejo, published in 1586, it is stated that when the soldiers returned to El Valle de San Bartolomé, Espejo was at *the mines of Santa Barbola (sic)* : in a later sentence the name is printed as *Barbora*. Geronimo de Zarate Salmeron spells the word as *Barbola*, but he was familiar with the above work and might have followed its spelling. Davis,<sup>2</sup> who had access to various old official documents, states that Espejo was at the mines of *Santa Barbara* ; a place of that name is situated eight leagues south of Hidalgo del Parral.

At first it appeared that the Santa Barbola of 1582 must be quite distinct from the Santa Barbara of the present day, for according to J. A. de Escudero,<sup>3</sup> the mineral veins at Santa Barbara were not discovered till 1747 : as shown below, the date is probably a misprint for 1547.

That the mines at Santa Barbara were worked by the Spaniards in the

<sup>1</sup> *Grande Encyclop.* Paris, 1889, vol. 8, p. 648.

<sup>2</sup> *The Spanish Conquest of New Mexico.* By W. W. H. Davis. Doylestown, Pa., 1869, p. 239.

<sup>3</sup> *Noticias Estadísticas del Estado de Chihuahua.* México, 1834, p. 129.



sixteenth century, and were antecedent to those of Parral itself, is shown by the following :<sup>1</sup>—

“ The mining place of Santa Barbara is in the Division of Hidalgo, and south-east of that town : it was discovered in the year 1547. Most of the mines have been abandoned since time immemorial, but they must have been very rich, for the veins have been worked out to their full extent.” “ The town of Santa Barbara, in the neighbourhood of Hidalgo (del Parral), was the first part of the State of Chihuahua to be peopled by the Spaniards. The formation of a town was begun in 1556, in consequence of the discovery of the mineral veins, and in the year 1600 there were seven thousand inhabitants employed in the working of the gold mines. The diminution of the yield at Santa Barbara, and the new discoveries made at Parral, had for result a transference of population to the latter town, and afterwards further north, in consequence of the discovery of Santa Eulalia, Cieneguilla, and later still Cusihiuriachic.” The identity of Santa Barbara and Santa Barbola is confirmed by the following statement :<sup>2</sup>— “ For the State of New Biscay, Lionnel Waffer (*sic*) mentions some silver mines, and gives Durango as the principal town : its other towns are called Barros, Sta. Barbara or Barbola Endehe, and San Juan.” Lionel Wafer’s voyages were made between 1677 and 1688 : a French translation of the account of his travels was published at Paris in 1706 under the title *Les Voyages de Lionnel de Waffer* : neither in the original nor in the French version does the form Barbola appear to have been used. Endehe or Ende is doubtless a separate place, and identical with the present Indé, 30 leagues S.E. of Sta. Barbara.

*The old landmark is identical with the mass now at San Gregorio.*

Not one of the four large masses, which still exist in the south of the State of Chihuahua, is at present situated within three leagues of the mines of Santa Barbara. The two at Chupaderos are far away from both the road to New Mexico and the mines ; it will be established later that the Concepcion mass was transported in 1780 from a place likewise far distant from any mining locality. The mass nearest to the place specified is that now at San Gregorio, a hacienda eight miles north-west of El Valle de San Bartolomé, and situated between that town and Parral : the hacienda is a league distant from the Parral road.

As shown below, its history, so far as known to us, is not inconsistent

<sup>1</sup> *Bot. Soc. Mex. de Geog. y Estad.* México, primera época, 1857, vol. 15, pp. 246, 272.

<sup>2</sup> *Allgemeine Historie der Reisen zu Wasser und zu Lande.* Leipzig, bei Arkstee und Merkus, 1755, vol. 13, pp. 508, 686.

with the view that the mass is the old landmark : no stress can be laid on the difference between the estimated weights (800 and 250 quintals). Yet the present location of the mass does not accord at all precisely with the specification given by Geronimo de Zarate Salmeron.

Santa Barbara is about ten leagues distant, in direct line, both from the hacienda of San Gregorio and from the highway (now in use and which has been in use for centuries) to New Mexico. A cart-road, however, now goes through Cerro Gordo, Torreon, Bocas, Cuevas and Hidalgo del Parral, and passes within three leagues of Santa Barbara ; if this road existed in the year 1600, and is the one referred to by Geronimo de Zarate Salmeron, the mass must have since been transported many leagues by the Spaniards. On the other hand, if the road through El Valle de San Bartolomé is signified, the distance of three leagues from Santa Barbara is much too small.

*The large "Durango mass" mentioned by Humboldt.*

After the large iron-landmark had been neglected and almost forgotten, outside its immediate neighbourhood, for two centuries, public attention was directed to the existence of such a mass by Humboldt, in his classic work on New Spain : unfortunately, owing to his ignorance of the previous history of the iron and his misunderstanding of the statement as to its situation in Mexico, his reference to it was of such a character that it has led to an incredible amount of controversy and vain searching of the country.

In describing the city of Durango, he says :<sup>1</sup>—" It is in the neighbourhood of (the city of) Durango that is seen, isolated in the plain, that enormous mass of malleable nickel-iron, which is identical in composition with the meteorite which fell near Agram, in Hungary, in 1751. Don Fausto d'Elhuyar, Director of the Royal School of Mines of Mexico, gave me some fragments which I have presented to various European collections ; and Vauquelin and Klapproth have published analyses of them. I am assured that this Durango mass weighs nearly 19,000 kilograms, which is 4,000 more than that of the mass discovered at Otumpa, in Tucuman (South America), by Rubin de Celis."

*Various opinions as to the "Durango mass" of Humboldt.*

Chladni (1819)<sup>2</sup> expressed the opinion that Humboldt had been wrongly

<sup>1</sup> *Essai cit.*, Paris, 1811, vol. 1, p. 293.

<sup>2</sup> *Ueber Feuer-Meteore*, Wien, 1819, p. 337.

informed, and that the big mass was identical with the comparatively small one at Charcas (578 kilograms): this opinion was based on the negative evidence that Sonneschmid<sup>1</sup> in his Review of Mexican Mining, published in 1804, had made no mention of a large mass near Durango. This line of argument is untenable, for Chladni, at least; since he himself acknowledges the existence of the Sierra Blanca masses, which are themselves unnoticed in Sonneschmid's work: the fact is that Sonneschmid was only describing the mineral districts which he had himself visited, and he incidentally mentioned the masses of meteoric iron at Charcas and Zacatecas, because they were in the districts being described: as none of the mines in the neighbourhood of El Valle were under discussion by him, we might have expected that the masses of meteoric iron belonging to that part of Mexico would be unmentioned, whether their existence was known to him or not.

Hardy (1829), as stated below, thought that the mass was possibly identical with that of San Gregorio.

Ramirez (1843)<sup>2</sup> denied the existence of the large mass near Durango, and expressed the view that the fragments given to Humboldt had been taken from the Zacatecas mass.

Partsch<sup>3</sup> (1843) and Boguslawski<sup>4</sup> (1854) thought they had been brought from Toluca.

Weidner<sup>5</sup> (1858) also denied the existence of the large mass, and expressed the opinion that the fragments were either from the Labor de Guadalupe, near Durango, or from one of the large masses "at Rio Florido and Concepcion."

Humboldt, on the other hand, still declined to regard the mass as mythical: he assured Burkart (1856) that D'Elhuyar had talked to him about the mass, not once, but a hundred times!<sup>6</sup> Burkart, thereupon, again made inquiry in Mexico, and heard (1857)<sup>7</sup> that a large meteorite really existed in the plain east of the city of Durango; and he was promised further information. This never arrived, and Burkart was informed by other persons that the mass was not to be

<sup>1</sup> *Mineralogische Beschreibung der vorzüglichsten Bergwerks-Reviere von Mexico oder Neuspanien*, Schleiz, 1804.

<sup>2</sup> *El Museo Mexicano ó Miscelanea Pintoresca de Amenidades Curiosas e Instructivas*, México, 1843-5, vol. 1, p. 29.

<sup>3</sup> *Die Meteoriten zu Wien*, 1843, p. 112.

<sup>4</sup> *Pogg. Ann., Ergänzungsband* 4, 1854, p. 411.

<sup>5</sup> *Bol. Soc. Mex. de Geog. y Estad.* Primera época, México, 1858, vol. 6, p. 61.

<sup>6</sup> *Neues Jahrbuch für Mineralogie*, 1856, p. 285.

<sup>7</sup> *Ibid.*, 1857, p. 53.

found :<sup>1</sup> being still not convinced that no such mass existed near the city, he suggested that the Breña—a volcanic group between Durango City and Nombre de Dios—should be closely searched. Later still (1866),<sup>2</sup> owing to the continued failure of the searches, he reluctantly inferred that Humboldt must have intended to indicate one of the Chihuahua masses, and that he had only mentioned Durango because there was no other big town in the neighbourhood.

Tarayre,<sup>3</sup> after a visit to Durango, thus reported (1867) :—“Several masses of meteoric iron are met with : one of them, weighing about 200 kilograms, is used as an anvil by a blacksmith of Durango. It was found in the neighbourhood of the city. There has been much talk of the large meteoric mass, *three-fourths buried in the plain*, not far from the hill called Mercado. Humboldt estimated the weight as 19,000 kilograms, according to information furnished to him at Mexico. The mass has never been dug out so as to permit of an exact estimation of the weight, and it appears there may be some exaggeration in the above figure.”

This statement, which seemed by its additional detail to confirm the existence of the mass, caused Burkart to resume his inquiries once more ; and, as a result, in 1871, he reported<sup>4</sup> that one person had been unable to find it, that another hinted that he knew where it was but was keeping the place a secret, while a third expressed doubts as to its existence ; in the end Burkart died without arriving at the true solution of the problem.

*The Huejuquilla masses were at one time known as “Durango iron.”*

And yet the explanation is an extremely simple one. At the time when Humboldt was in Mexico, and for many years afterwards, till the rebellion against Spain, the Province of Durango or New Biscay included, not only the present State of Durango, but also those of Chihuahua and Coahuila : hence the whole Huejuquilla group was then in the *Province* of Durango ; and before other masses had been found in the same Province, they could very appropriately be termed “Durango iron.” Humboldt merely misunderstood the intended meaning of the term Durango, taking it to be the City instead of the Province.

That this is the true explanation there cannot be a shadow of a doubt. The structure of Humboldt’s initial sentence clearly indicates that he was referring to some large mass of which the existence at the time of writing

<sup>1</sup> *Neues Jahrbuch für Mineralogie*, 1858, p. 773.

<sup>2</sup> *Ibid.*, 1866, p. 408.

<sup>3</sup> *Archives de la Commission Scientifique du Mexique*, 1867, vol. 3, p. 270.

<sup>4</sup> *Neues Jahrbuch für Mineralogie*, 1871, p. 851.

was a matter of common knowledge: though, indeed, the suggestion of common knowledge may be wholly based on the publication of the analysis of his fragment by Klaproth in 1807.

But the "iron-landmark," in the Province of Durango, near latitude  $27\frac{1}{2}^{\circ}$ , had been then known for more than two centuries: since 1780 the Concepcion mass, also in the Province of Durango and situated "upon a level plain, twenty miles from any mountain," had been lying close to a line of traffic, along which, at the time when Humboldt was in Mexico (1803), thousands of mules were passing every week: an account of the discovery of large masses of iron at Sierra Blanca, in the same Province, had been published in Mexico City in 1784: a notice of the finding of a mass at La Plata, also in the same Province, had been similarly published in 1802. At the time of Humboldt's visit, no Mexican Province was comparable with Durango for the number of its isolated iron-masses, and the fact must have been perfectly well known to the mineralogists in Mexico City. Indeed, Del Rio, Professor at the Royal School of Mines at Mexico, in his *Mineralogical Tables*<sup>1</sup> (1804) cites the *Province of Durango* as a locality for native iron; and in the *Second Part of his Mineralogy*<sup>2</sup> (1805), under Native Iron, he mentions "the mass weighing 300 quintals which Rubin de Celis found on a vast plain of South America, and those which are found in the Province of Durango under similar circumstances." He gives no more precise information than the above. This text-book Humboldt was familiar with: indeed, his name appears on the title-page of the *Second Part*, for he contributed to that Part an essay on the geology of the country: in his own description of New Spain,<sup>3</sup> too, he expressed his indebtedness for mineralogical information to the works of both Sonneschmid and Del Rio. It is thus impossible to escape the conclusion that the large Durango mass, about which Humboldt had often conversed with D'Elhuyar, was the one which had been lying near the road to Chihuahua and in the Province of Durango or New Biscay, ever since the arrival of the Spaniards in Mexico.

And at the time when Humboldt's statement was published, his verbal misapprehension was doubtless considered by the Mexican mineralogists to be of so trivial a character that correction by them was unnecessary: as we shall see later, Hardy, who was the first to note the presence of a mass at San Gregorio itself, suggested its identity with Humboldt's Durango mass. It was not till many years after Humboldt's visit that the assignation

<sup>1</sup> *Tablas Mineralogicas*; México, 1804, p. 57.

<sup>2</sup> *Elementos de Orictognosia*, Segunda Parte, México, 1805, p. 40.

<sup>3</sup> *Essai cit.*, vol. 1, *Introduction géographique*, p. L.

of the El Valle and Huejuquilla district to the State of Chihuahua rendered the term "Durango iron" quite inappropriate, and thus made Humboldt's statement quite inexplicable even to those living in Mexico.

[In the Index of the *Gazetas de México* for 1793, there is a reference to a notice on page 59 'De acero de peso de 2,000 arrobas.' A complete copy of the Gazette for that year is preserved neither in London nor Paris. The weight 2,000 arrobas (or 500 quintals) approximates to that mentioned by Humboldt.]

No stress can be laid on the discrepancy between the estimated weight of the "Durango" mass (19 tons) and the latest estimate of that of the San Gregorio mass (11 tons). Estimates of the weights of such masses depend very much on the estimator: the iron-landmark was supposed three centuries ago to weigh about 40 tons (800 quintals); the San Gregorio mass was stated by Butcher to weigh about 5 tons. The larger of the two masses at Chupaderos weighs, according to one recent estimate  $15\frac{1}{2}$  tons, according to another 82 tons.

The labels of those "Durango" fragments which have been given to European collections by Humboldt may thus be safely altered to indicate that the fragments belong to the Huejuquilla group: if taken from the big mass mentioned by him, they are fragments of that of San Gregorio; but if they were given to him merely as "Durango iron," they may belong to any of the masses of the Huejuquilla group known at that date.

*Humboldt only referred to the more important masses previously recorded.*

We may incidentally remark that the only Mexican masses of iron mentioned by Humboldt<sup>1</sup> are all remarkable as being either individually large (Durango, Zacatecas, Charcas), or as forming a numerous group (Toluca): that if we take Durango to indicate a "Province of Durango" mass, all of them are included in those previously mentioned by Del Rio and Sonneschmid; and that of the remainder mentioned by one or other of those two writers, but omitted by him (namely, Misteca and Guangoche), almost nothing was at that time known."

It is obvious that Humboldt's remarks were made under the impression that he was merely making mention of masses which had already attracted much notice in Mexico itself.

*Supposed meteoric origin of the hill called Mercado.*

Humboldt's misinterpretation of the term *Durango iron*, led to a wild

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<sup>1</sup> *Essai cit.*, vol. 1, p. 293; vol. 2, p. 582.

misinterpretation of Humboldt's own statement; for, as no mass of meteoric iron was known in Durango City to be lying on the neighbouring plain, it came to be a matter of common belief that Humboldt was referring to the Cerro Mercado, a hill close at hand, and was expressing the opinion that the Mercado is nothing else but an immense meteorite! In 1846 Ruxton passed through Durango City, and the confusion at that date is illustrated by the following remarks :<sup>1</sup>—

“Durango is celebrated for the enormous mass of malleable iron which rises isolated in the plain about three miles from the town. This rock is supposed to be a meteorite, as its composition and physical character are identical with certain meteorites which fell in 1751 in some part of Hungary, and analogous to the general character of others of the same nature, of which the meteoric origin is equally certain and authenticated. It contains 75 per cent. of pure iron, according to the analysis of a Mexican chemist; and some specimens, which Humboldt procured, were analysed by the celebrated Klaproth with, I believe, the same result.”

The general prevalence of this belief is sufficiently shown by the fact that in 1843 Ramirez,<sup>2</sup> and in 1858 Weidner,<sup>3</sup> published memoirs relative to the Mercado, in which they deemed it necessary to disprove in an elaborate way the meteoritic theory of its origin, supposed to have been brought forward by Humboldt.

It need scarcely be said that Humboldt never expressed such an opinion: in his work on New Spain, it is true, he mentioned the hill called Mercado and the Mexican meteoric irons almost simultaneously, but merely because he was describing the modes of occurrence of iron in Mexico, and the Mercado was known by the Mexican mineralogists to be an enormous mass of iron-ore. In fact, Humboldt himself never travelled so far north as Durango, and could only give such information about the hill as had been supplied to him by others.

#### *Hardy:*

After Humboldt's reference, the next mention of the mass was made by Hardy,<sup>4</sup> who travelled through the neighbourhood in 1827: it is the first record of the presence of the mass at San Gregorio. He says:—

<sup>1</sup> *Lib. cit.*, p. 86.

<sup>2</sup> *El Museo Mexicano ó Miscelanea Pintoresca de Amenidades Curiosas e Instructivos*, México, 1843-5, vol. 1, p. 28.

<sup>3</sup> *Bol. Soc. Mex. de Geog. y Estad.* Primera época, 1858, vol. 6, p. 59; and *Neues Jahrb. f. Min.*, 1858, p. 769.

<sup>4</sup> *Travels in the Interior of Mexico in 1825-8.* By R. W. H. Hardy. London, 1829, p. 481.

“From the hacienda of Santa Cruz to the Real del Parral the distance is 12 leagues. Nine leagues on the same road is the town of San Gregorio, where there is an enormous mass of malleable iron and nickel, perhaps the meteorite which Mr. Humboldt describes as being near the town of Durango. Real del Parral had formerly a population of fifty or sixty thousand souls, and was very celebrated in its day, which has now gone by. Many attempts have been made to melt down this mass of iron, but without success. An Italian imagined that by heating one side of it he should be able to cut off as much of the metal as he wanted. Accordingly he piled on the part where he intended to commence his operations an immense quantity of wood to which he set fire, and by dint of united blast of five or six forge-bellows he succeeded in giving it a red heat, which indeed was so insupportable that to his astonishment he could not come near it. However, I am told that, by applying a wall of thick boards before him, he succeeded in obtaining three pounds of iron; which three pounds cost him 130 dollars, and they were not worth four.”

Hardy left the hacienda of Rio Parral (not Real del Parral) at 5 a.m., reached Santa Cruz at 8 a.m., and was in El Valle de San Bartolomé at 8 p.m. the same day: there is an element of doubt as to whether he can have had time to go to the hacienda to see the mass, for it is some distance from the road to El Valle: he gives no description of the mass or of its position, and fails to mention the inscription upon it, which, according to one account, is dated 1821.

The population of El Valle was then 28,000.

#### *Bartlett.*

Bartlett heard of the existence of the San Gregorio mass in 1852, but he did not journey to see it.<sup>1</sup>

#### *Butcher and Lawrence Smith.*

Dr. Butcher detached some fragments and sent them to Professor Lawrence Smith,<sup>2</sup> who published (1871) a sketch of the mass, and said:—“Upon one part of its surface 1821 is cut with a chisel, and above this date the following inscription in Spanish, ‘*Only God in his might can destroy this iron, for none on earth is able to divide it.*’ It lies within the enclosure of a hacienda, having been hauled to the ranch many years ago by the Spaniards, who thought that it could be made use of as iron for farming

<sup>1</sup> *Lib. cit.*, vol. 2, p. 458.

<sup>2</sup> *Amer. Jour. Sc.*, 1871, ser. 3, vol. 2, p. 336.



utensils. It is said to have fallen quite near its present site, and from its huge bulk and weight, which is calculated to be about 5 tons, it could not have been transported very far. Nothing more is known of its history."

The place designated throughout as El Para by Lawrence Smith is really Parral (or Hidalgo del Parral).

*Parras.*

Burkart<sup>1</sup> (1871) quotes an account of the mass communicated to him in a letter by Don Anastasio Parras (not Porras) of El Valle de San Bartolomé: mention is made of the attempt to reduce the mass, and also of the above inscription, but the inscribed date is given as 1828, a date subsequent to that of Hardy's journey. Parras further says that the mass must have fallen  $7\frac{1}{2}$  leagues from the hacienda of San Gregorio; that no one knew at what time it had fallen; but that it was certainly long ago, for since the beginning of the eighteenth century, the mass of iron, laid bare by the rain, had been used as a boundary-mark of the hacienda of San Gregorio and the landed property of the town of El Valle. Parras states that the mass was moved to the square of the hacienda about fifty years before the date of his letter.

As Parras says that the mass was unknown till its discovery near the boundary, there must be an error of printing in his statement of the distance of removal, for the hacienda is only eight miles from El Valle itself: probably  $1\frac{1}{2}$ , not  $7\frac{1}{2}$ , was written by him.

Even if the previous history had been actually lost, as Parras supposed, we might have safely inferred that the mass could not have been lying near so important a town as El Valle for one or two centuries without being discovered, and that the mass had been known to former inhabitants of the town before the occasion when it was again laid bare by the rain.

We shall see that exactly the same account of revelation by a shower of rain, within a short distance from the hacienda, was given for the Concepcion mass, in 1871, by the actual owner, and yet it is now established that the mass had been removed from near Huejuquilla in 1780: it is remarkable, too, that there is almost exactly the same tradition relative to the attempt to cut large pieces from the two masses.

*Castillo.*

Castillo (1889)<sup>2</sup> says:—"It fell at the place called El Morito,  $4\frac{1}{2}$

<sup>1</sup> *Neues Jahrbuch für Mineralogie*, 1871, p. 853.

<sup>2</sup> *Cat. Des. cit.*, p. 7.

kilometres from the hacienda of San Gregorio, and the then proprietor (? 1600), Raphael de Pastrana, had it transported to the square of the hacienda, where it still lies."

*Knotts.*

In a letter sent in answer to my inquiries, Mr. J. D. Knotts of Parral states that, according to local tradition, the mass was moved, some 130 or 140 years ago, to the hacienda of San Gregorio from El Morito, about two leagues distant in an easterly direction. About four or five years since it was moved by the present owner from the centre to the corner of the hacienda, about 70 feet, to form part of the house: 50 men with levers were employed in the latter removal.

**B. The Concepcion mass.**

The following are the accounts which have been published at various times relative to the mass now at the hacienda of Concepcion:—

*Connolly.*

Henry Connolly,<sup>1</sup> Governor of New Mexico, with whom General Carleton had been discussing the meteoric iron of Tucson, gave him the following information:—"In the State of Chihuahua, and at the hacienda of Don Juan Nepumocena Urquida (*sic*), say 180 miles south of the city of Chihuahua, and directly on the road from that city to Mexico, and directly among the houses of the above-named hacienda, on the left hand side of the road going to the city of Mexico, and within from 30 to 50 yards of the main road, is what is supposed to be a meteorite. I saw it nearly every year for 20 years, the last time in 1846. It is a large mass of solid iron, standing like a post in the earth, from which it projects vertically about 4 feet. Its diameter at the surface of the earth is from 2 to 3 feet. It diminishes in size a little from the earth to its apex, which is irregularly rounded. The part above the ground would weigh a ton or more."

*Lawrence Smith and Weidner.*

Probably this is the mass which had been previously referred to by Lawrence Smith in 1854-5:<sup>2</sup>

<sup>1</sup> *Smithsonian Report for 1865*, p. 124.

<sup>2</sup> *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160.

“ Weidner, of the mines of Freiberg, states that near the south-western border of the Bolson de Mapimi, on the route to the mines of Parral, there is a meteorite near the road of not less than a ton in weight.

According to Manuel Orozco y Berra,<sup>1</sup> Weidner was at Parral, in the year 1850, as engineer to the Prieta and Tajo Mining Company, and published plans of the mines ; in the same year he prepared a description of the route from Parral to Durango and Monterey (*Itinerario y carta geognóstica del camino del Parral para Durango y Monterey, formada en 1850 por Federico Weidner*). The statement quoted by Smith is probably taken from the latter work, a copy of which is inaccessible to me.

*Simson.*

Robert Simson,<sup>2</sup> writing about the year 1866, but quoting from memoranda made at some previous time, says :—“ About halfway between El Valle and Parral, on a bend of the Río Florido, at a place called Concepcion, is a most splendid specimen of meteoric iron. It is 4 feet above ground, and almost pure in quality. It is from two to three feet one way, by probably two to five feet the other, very regular in shape, and where worn by the rubbing of hands, &c. of passers-by is bright, and to all appearance, is nearly pure metal. The steel hatchet cuts into it easily, but with our means at hand we found it impossible to detach any part of it. It stood at the corner of the house, apparently to guard it from collisions of wagons and the like. The majordomo said this meteorite had, as he had heard, fallen from the heavens, and had been brought from a distance, from a place where other specimens also existed. Such we found to be the prevailing account of this mass among the people of the place. I would state that from La Concepcion to the Río Grande there is an excellent road leading through Saltillo and Monterey, and save in respect to its weight, there would be no difficulty in conveying this meteorite (to the United States). The common carts of the country, with solid wooden wheels, could well convey it.”

There is an error in the above statement of locality, for the hacienda of Concepcion does not lie between El Valle and Parral ; indeed, El Valle itself is halfway between Parral and the hacienda of Concepcion : as discussed above, there is a large mass at San Gregorio between El Valle and Parral, but being distant from the main road it does not attract as much notice from travellers ; Simson's letter is of special importance as a record

<sup>1</sup> *Apuntes para la historia de la Geografía en México.* México, 1881, p. 364.

<sup>2</sup> *Smithsonian Report for 1867,* p. 472.

of the tradition of the removal from a distant place, where other masses were still lying, and of the excellence of the roads in its neighbourhood.

*Bartlett and Urquidi.*

Bartlett,<sup>1</sup> who was travelling in 1852 by way of Huejuquilla and Rio Florido, made an excursion from his direct route to view the mass : he says:—

“ We came to a small stream, where, encompassed in a grove of cottonwoods, lay the pretty village (Concepcion) to which we were destined. On our arrival we stopped under the shade of some large trees, and dismounting at once discovered the object of our search, about 50 yards distant, at the corner of a large building. This was the residence of Don Juan Urquida (*i.e.* Urquidi), the proprietor of the hacienda and large estates adjoining, and formerly Governor of the State. That no time might be lost, Dr. Webb immediately set to work with his hammer and cold chisels to cut off some pieces from the large mass of iron before us. This he found to be an undertaking of great labour, in consequence of the extreme tenacity and hardness of the mass. After an hour’s work with a man to assist him, he succeeded in cutting off 3 or 4 small pieces, which did not altogether weigh an ounce, and were barely sufficient for an analysis. Five chisels having been broken, the doctor had to desist from his labours, much to our regret, as we were desirous to obtain some specimens for cabinets. While this was going on I took a couple of sketches of the mass showing opposite sides, and also took measurements ; but the form was so irregular that these measurements can only aid in conveying an idea approximately of its bulk. Its greatest height is 46 inches ; greatest width 37 inches ; circumference in thickest part 8 feet 3 inches. Its estimated weight, according to Señor Urquida, is 3,853 lbs. While we were at work, Señor Urquida the younger, the brother of Don Juan, came out. He said it was originally found about 300 *varas* (270 yards) from its present location, and had been moved at different periods by the people of the hacienda to the place where it now stands. It was brought hither with the design of putting it in a blacksmith’s shop to be used as an anvil, although it had never been so employed. An attempt was made to reduce it, by building a large fire round it and heating it to a white heat. But so intense was the heat from so large a mass that the workmen could not approach it, and all their labour was lost. The expense of this operation was more than 100

<sup>1</sup> *Lib. cit.*, vol. 2, p. 457.

dollars, and resulted in obtaining a piece of the metal large enough to work into a pair of spurs."

*Urquidi.*

An account of the Concepcion mass, published by Francisco de P. de Urquidi,<sup>1</sup> places on record as much as was known, in August 1871, at the hacienda itself.

The following extracts relate to the history:—

"The place at which the mass is now located is not that which was first known. By tradition we know, though in an indirect and inexact way, that at a time very remote it was at a point distant more than 1,000 *varas* from the *casa principal* of the hacienda: according to the same tradition, the mass was transported to the neighbourhood of the *casa principal* and placed in front of the church door. There it was known by persons who have not yet been long dead. At the beginning of this century, a manager of the hacienda sought to profit by transporting it to a forge to be used as an anvil: it was at the door of that workshop when the present owners (*i.e.* Urquidi) of the hacienda first knew it: from there they had it moved to the spot where it now is, at a corner of the *casa principal*, and had it placed on a small pedestal of masonry. Many little pieces have been hacked from the mass; from some of them have been forged various articles of smithy-work, others have been taken away as specimens. In the same district there are three other masses quite similar in their material: one 12 leagues to the north-west, at a hacienda called San Gregorio, and the other two at 25 or 30 leagues to the north-east, at 160 paces from each other, in a part of the desert of the Bolson de Mapimi, near a place known as Chupaderos, on a hill outside the mountain-ridge. No other mass of this kind is known to exist in all this extensive territory, unless it be the Tucson iron, which, along with that of Descubridora, may possibly have fallen from the same meteor."

Burkart,<sup>2</sup> though apparently quoting from what is virtually the same account, mentions one or two points not in the above paper: they may have been given as marginal notes on a copy sent to him, along with a fragment of the mass, by Urquidi: he says that according to report the mass had been laid bare in the copse, about 800 *varas* from its present position, in a water-course produced by a violent shower; and that the mass was still near the smithy in 1823.

<sup>1</sup> *Bol. de la Soc. Mexicana de Geog. y Estad.* Segunda época, 1871, vol. 3, p. 275.

<sup>2</sup> *Neues Jahrbuch für Mineralogie*, 1871, pp. 852-3.

*Castillo and Urquidi.*

According to Castillo (1889),<sup>1</sup> F. Urquidi states on the authority of a letter of his uncle, A. Urquidi, that the mass was transported to Concepcion from the Sierra de las Adargas, near Huexuquilla (*sic*) on 29th April, 1780. Apparently Urquidi must have discovered the letter since the publication of his paper in 1871: the latest information is thus in much closer agreement with the statement made by the majordomo to Simson before the year 1866.

Sierra de las Adargas is not given on the available maps, but Don José de la L. Soto, the owner of the hacienda of Chupaderos, informs me that the name is applied to a hill (*pequeña montana*) eight or nine leagues south of the town of Jimenez (Huejuquilla), and within that jurisdiction.

**C. The Río Florido mass.**

The town of Río Florido is at the junction of the roads which lead from Huejuquilla and El Valle de San Bartolomé respectively to Durango City. Hardy says:<sup>2</sup>—"I left El Valle at 7 a.m. and arrived at the hacienda of Concepcion at eleven. This I passed, and reached the hacienda of Río Florido at 3 p.m. The house is a palace, with a long colonnade in front. It was built by Father Juan Cerera, a Spanish priest, during whose lifetime the hacienda was celebrated as one of the richest in Mexico."

The mass said to have been at the hacienda of Río Florido appears to be really identical with that of Concepcion.

The information relative to the mass is small. Weidner<sup>3</sup> first referred to it incidentally in 1858:—"I have actually seen, on the very edge of the road from Durango to Chihuahua, at the haciendas of Río Florido and Concepcion, two masses of malleable iron which appear to be meteorites." Castillo<sup>4</sup> (1889) says:—"In 1866, Federico Weidner, when giving me some information relative to the meteorites of the Northern States of Mexico, spoke to me of a mass which was at the hacienda of Río Florido, on the old highway from Mexico to Chihuahua. The mass was about half as large as that at the hacienda of Concepcion, flatter than the latter, but presenting the same characters. As Weidner assured me that he had hacked some fragments from it, I mention the mass here: I have been

<sup>1</sup> *Cat. Des. cit.*, p. 7.

<sup>2</sup> *Lib. cit.*, p. 483.

<sup>3</sup> *Eol. Soc. Mex. de Geog. y Estad.* Primera época, 1858, vol. 6, p. 61.

<sup>4</sup> *Cat. Des. cit.*, p. 9.

unable to find any other description of it, and during my visit to the hacienda of Rio Florido itself, in March last (1889), I could neither find the mass, nor get any information relative to it." In answer to inquiries from Burkart<sup>1</sup>, made through Stahlknecht of Durango, Weidner wrote, on 10th September, 1870:—"During a journey to Chihuahua, I saw two masses, one at the hacienda la Florida (*sic*), the other at the hacienda Concepcion. Without delaying the caravan I was able to hammer off a small piece of the *former* meteorite, and of the external character of this mass I remember the following:—It has no predominant form, and could at most be compared with a heavy club. The thinner part is buried deep in the earth, the free, visible, broader part is about a metre high and 40 centimetres thick. Its surface is rounded and kidney-shaped; everywhere smooth, and in parts bright, like polished steel, although covered here and there with pores. An outer rind or black crust, differing from the interior, is not observable. In hardness it seemed to be equal to cast iron; its section was fairly smooth: on its fractured parts it showed a hackly appearance, like that of silver. From its place of preservation and its position, one may infer that it has been hauled thither by the landlord from somewhere in the neighbourhood, and has been sunk in the earth close to the corner of the house as a corner-stone."

In 1866, Whitney<sup>2</sup> remarked:—"Dr. J. B. Trask saw in August 1849 a large mass of meteoric iron at the village of Rio Florida (*sic*), partly buried in the ground at the corner of the *plaza*. This may perhaps be the same mass mentioned by Mr. Bartlett as existing at the hacienda of Concepcion, on the road from Chihuahua to Rio Florida. Dr. Trask, however, has a distinct recollection that the mass he saw was at the village of Rio Florida, and not at the hacienda."

Abner Woodworth,<sup>3</sup> in 1866, wrote to the Secretary of the Smithsonian Institution:—"On the 7th of March, 1843, I left Paral (*sic*), a town situated on the river Allende, State of Chihuahua, and travelling some 25 miles, course 15° east of south, passed a lump of solid malleable iron, shape or figure resembling two inverted saucers, one-third or more buried in the ground, supposed to weigh 5 or 6 thousand pounds. The blacksmith at Rio Florido cuts off pieces with his cold chisel for horseshoes. It lies upon a level plain, 20 miles from any mountain."

*Comparison of the statements.*

The statements made by Trask and Woodworth are useful as suggesting

<sup>1</sup> *Neues Jahrbuch für Mineralogie*, 1871, p. 854.

<sup>2</sup> *Proc. Calif. Ac. Nat. Sc.*, 1866, vol. 3, p. 241.

<sup>3</sup> *Smithsonian Report* for 1867, p. 472.

an interpretation which may be given to Weidner's report. Woodworth only mentions a single mass: the San Gregorio mass being a league from the road escaped his notice, but as is proved by the descriptions of Simson and Bartlett, the Concepcion mass was so conspicuous that it continually attracted the attention of passers-by and was hacked by them at discretion. Woodworth is not likely to have missed such a specimen, and have observed one of which almost nothing is known, and which is said to have been only half the size of the Concepcion mass. Simson himself refers to the stream which passes close by Concepcion as a bend of the Rio Florido: as a matter of fact, two different streams pass by the villages of Concepcion and Rio Florido, and unite about 12 miles away. Such a fact would be unknown to an ordinary traveller, whose journey along an excellent road could necessitate no reference to a detailed local map, even if such a map had then existed: the stream now called Rio Florido is the more important one, and the course of the road from the village of Rio Florido to Huejuquilla is determined by it.

There is a similar misapprehension, as regards Rio Allende, on the part of Woodworth; for Parral is not on the stream passing through Allende (El Valle), but on another stream (Rio Parral) which joins the Rio Conchos or Florido at Santa Rosalia, more than sixty miles distant from Parral.

Taking these things and the stated distance from Parral into consideration, and remembering that for many years the Concepcion mass had lain close to the smithy, it cannot be doubted that Woodworth's 'blacksmith at Rio Florido' was really the 'blacksmith at Concepcion, on a branch of the Rio Florido.' If this be granted, Trask's statement also falls to the ground: his distinct recollection that "the mass he saw was at the village of Rio Florida (*sic*) and not at the hacienda," would merely imply that the mass was outside the hacienda (of Concepcion): indeed, Bartlett's description indicates that the hacienda and village are virtually identical in location, and Connolly says that the mass was directly among the houses of the hacienda up to 1846 at least.

The statement of Weidner now becomes more capable of interpretation: his description of the position and characters of the mass at "Rio Florido" agrees so well with those given by Simson and Bartlett for the Concepcion mass, that it is impossible to come to any other conclusion than that the two masses are identical: and further, that Weidner's second and larger mass was not that of Concepcion, as stated by him, but the one at San Gregorio. Of the existence of the latter, though the mass is not directly referred to, he can scarcely have been ignorant: for, as already mentioned, he was employed for some time in the neighbourhood as engineer at



Parral, and his familiarity with the region is established by the fact that he had constructed a geological chart of the road from the mines of Parral (through El Valle, Concepcion, Rio Florido, Cerro Gordo) to Durango and Monterey.

As stated above, Lawrence Smith<sup>1</sup> (1854-5) says :—"Mr. Weidner, of the mines of Freiberg, states that near the south-western edge of the Bolson de Mapimi, on the route to the mines of Parral, there is a meteorite near the road of not less than a ton in weight."

The search for a published authority for this statement of Lawrence Smith has been fruitless ; as suggested above, it may have been quoted from the *Itinerario* of 1850 : the statement is of particular interest as showing that before 1854 only a single mass, apparently that of Concepcion, had been specially called attention to by Weidner.

Weidner states that he broke off the fragments at Rio Florido "without delaying the caravan" : his information may thus have been acquired very hurriedly and be inexact, though it is still difficult to explain away his statement that *both* masses were close to the edge of the road.

If any further confirmation be required of the possibility of the confusion of the two villages of Concepcion and Rio Florido, by reason of the small stream passing through the former being a tributary of the larger one passing through the latter, it is given by the following extract from a memoir by Pedro Garcia Conde relative to the State of Chihuahua (1857) :<sup>2</sup>—

"In the hacienda of Concepcion, *which is situated on the banks of the Rio Florido*, there is a mass of native iron got from two small hills (*sic*) in the neighbourhood, which contain so large a quantity of magnetic iron ore that they appear to be wholly composed of that mineral. The mass referred to has a volume of about 60 cubic feet, and is composed of so malleable an iron that one of the *owners of the Rio Florido*, from curiosity, collected a considerable quantity of timber : setting fire to it they succeeded in making the mass red hot ; and with much trouble, for the heat would not allow of anyone remaining near the mass, they severed a piece, and from it the owner had some horse-trappings (*montura*) made for him. The smith who forged them said that he had never worked any other iron with such facility."

The mass referred to by Conde is clearly that which is now at the hacienda of Concepcion, and is identical with the 'Rio Florido' mass mentioned

<sup>1</sup> *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160.

<sup>2</sup> *Bol. Soc. Mex. de Geog. y Estad.* · Primera época, 1857, vol. 5, p. 251.

by Simson; and the same may be said of the 'Rio Florido' mass of Weidner, Trask and Woodworth.

#### D. The two Chupaderos masses.

According to Castillo, only two masses are known to exist in the district east of Huejuquilla, namely those near the rancho (or hacienda) of Chupaderos, 17 miles east of the town: they are only 250 metres apart.

We have already proved that these masses are not, as has been supposed, identical with the ancient landmark referred to in the History of Philip the Second.

The earliest reference I have been able to trace relative to the Chupaderos masses is the following made by Bartlett,<sup>1</sup> who passed through the town of Huejuquilla in 1852, and sent a party to visit the masses of which he had heard mention:—

“Dr. Webb procured a guide in the town who professed to know where they were to be found: he set off from camp with our ten soldiers and three others of our party, but returned next day without having found them. It appeared that, on reaching the place designated, the guide became somewhat confused; and on being questioned more closely, acknowledged that he had not been there for twenty years: he declared it was not safe to go further on account of the Indians. The doctor, however, compelled him to lead them about for miles in every direction, but to no purpose.”

Bartlett, nevertheless, expressed his belief in the existence of the masses:<sup>2</sup>—“From the various inquiries, made at Huejuquilla and at the hacienda of Concepcion, I learned of the existence of meteorites or masses of native iron in several places. Of those near the former place, of which Dr. Webb went in search, there is no doubt. Some of them are very large masses; while others are less than the one described (Concepcion).”

In a paper on the meteoric irons of the Bolson de Mapimi and its neighbourhood, after mentioning the masses at San Gregorio and Concepcion, Lawrence Smith<sup>3</sup> referred, in 1871, to “the locality of a huge meteorite lately discovered, of which no specimen has yet been detached, and which is said to be larger than any yet found in that locality:” and in 1876 he said:—“We have some account of one even larger than San Gregorio, located in the very centre of the desert.”

<sup>1</sup> *Lib. cit.*, vol. 2, p. 453.

<sup>2</sup> *Ibid.*, p. 458.

<sup>3</sup> *Amer. Jour. Sc.*, 1871, ser. 3, vol. 2, p. 337: 1876, vol. 12, p. 107.

These remarks doubtless refer to the same mass, and were probably based on vague information relative to the meteoric iron of Chupaderos.

### E. The Sierra Blanca masses.

*Discovery of iron masses in the Sierra Blanca, near Huejuquilla.*

The following paragraph appeared in the *Gazetas de México* for Wednesday, 8th September, 1784: "In the *Sierra blanca*, three leagues from the Villa Nueva de Huajuquilla (*sic*) and twelve from El Valle de San Bartolomé, various masses of iron weighing 20, 30 and more quintals (hundredweight), have been discovered: fire has been put to them, and some pieces have been cut off with chisels: they proved to be workable, but owing to the expense the attempts have been given up."

*Sierra Blanca* is not given on any available map; but as the hills near Huejuquilla are composed of limestone the name *Sierra Blanca* would not be inappropriate to most hills in the neighbourhood.<sup>1</sup> Mr. Knotts of Parral sends me the information that the name was formerly used to indicate what is now termed locally the "Sierra de la Maloya," and that the sierra is eight leagues west of Huejuquilla: this must be identical with the Cerro Almoloya of the maps, which is eight leagues from Huejuquilla and five from El Valle measured in direct line; the distances do not accord very satisfactorily with those mentioned in the Gazette.

A fragment of meteoric iron, labelled "Ein Stück Meteoreisen aus der Sierra blanca unweit Villa nueva de Haxuquilla (*sic*) in Mexico," was mentioned by Kayser in 1834 in his description of the Mineral Collection of Dr. Bergemann:<sup>2</sup> the specimen eventually passed into the Berlin Collection, and from it have been cut the small pieces now in several Meteorite Collections under the name *Sierra Blanca*.

It is remarkable that in the above report there is mention only of the occurrence of masses in a locality of which the name is not to be found on the maps, and that there is not the slightest direct reference to the still larger masses now at Concepcion, San Gregorio, and Chupaderos in the same region, although two of the places are near a road which has for centuries been the important highway to Chihuahua and New Mexico, and one of the masses had been an important landmark at the end of the sixteenth century.

The report mentions the existence of "various masses, weighing 20, 30

<sup>1</sup> *Memoir of a tour to Northern Mexico, &c.*, by Wislizenus, 1848.

<sup>2</sup> *Beschreibung der Min. Samm. des Herrn Bergemann*, Berlin, 1834, p. 465.

and more quintals," of which only the fragment acquired by Dr. Bergemann would seem to have been preserved.

### F. The Tule fragment.

The information relative to the iron of Tule is very slight. Castillo (1889)<sup>1</sup> says:—"In the Engineering School of Mexico is a small fragment of meteoric iron from Tule, Balleza, Chihuahua. There is no indication that the fragment has been severed from one of the large Chihuahua masses, or indeed from any other block."

The rancho of Tule, in Balleza, is 100 miles west of Chupaderos. In the absence of any history or description, the presence of the fragment at Tule within recent years is no proof that it had fallen in the neighbourhood, and still less that it had fallen with the Huejuquilla group, of which the terrestrial age was already beyond the memory of man more than three centuries ago.

#### *Chemical analyses of the masses of the Huejuquilla group.*

Though some analyses of fragments of masses of the Huejuquilla group have been made, the results are far from satisfactory: the difference in the numbers for a single mass (San Gregorio) are such that it is impossible to lay any stress on the variations in the analytical results for the members of the group.

	Humboldt's Durango.		San Gregorio.			Concepcion.		Chupaderos.
	a. Klaproth, 1807.	b. John, 1821.	c. Smith, 1871.	d. Rammelsberg, 1870.	e. Lumbier, 1880.	f. Rammelsberg, 1870.	g. Lumbier, 1880.	h. Rammelsberg, 1870.
Iron .. ..	96.75	91.5	95.01	89.6	90.4	..	89.0	..
Nickel .. .	} 3.25	6.5	4.22	} 10.4	9.4	10.23	10.9	5.12
Cobalt .. .		2.0	0.51					0.82
Phosphorus ..	..	..	0.08	..	..	..	..	..

a. The fragment was sent to Klaproth by Humboldt as from the large "Durango" mass. (*Beiträge zur chem. Kennt. d. Mineralkörper*; M. H. Klaproth, 1807, vol. 4, p. 102.)

b. Of the fragment analysed by him, Professor John of Berlin says that it was part of the "Mexican mass, well-known and already investigated by

<sup>1</sup> *Cat. Des. cit.*, p. 7.

some chemists. It is that for which Humboldt is the authority, but I am uncertain as to whether the discovery was made by him or Sonneshmid." (*Schweigger's Journal für Chemie und Physik*, 1821, vol. 32, p. 263.) The specimen was doubtless part of the "Durango" mass, and one of those referred to by Humboldt as given by him to various European Collections.

*c.* The fragment was sent to Smith by Butcher. (*Amer. Jour. Sc.*, 1871, ser. 3, vol. 2, p. 336.)

*d, f, h.* The fragments of San Gregorio and Concepcion, and probably also that of Chupaderos (not "Chupanderes") were sent to Rammelsberg by Burkart. (*Neues Jahrb. für Mineralogie*, 1871, p. 852; *Die chem. Nat. d. Met.* von C. Rammelsberg, 1879, pp. 31, 32.)

*e, g.* The fragments were got from Urquidi, the owner of the Concepcion mass. (*Los Aerólitos de Chihuahua*, por Baltasar Muñoz Lumbier; México, 1880, pp. 16, 17.)

### III. STATE OF SINALOA.

#### The Ranchito mass.

In 1876 Professor Barcena<sup>1</sup> mentioned the existence in Sinaloa of an enormous mass of meteoric iron more than 12 feet long, and stated that a chemical analysis by himself of some fragments sent to Mexico City was in progress: no detailed description, however, seems to have yet been published, but Barcena states that the components are essentially iron and nickel, and that the fragments are silver-white and grayish in colour.

Castillo (1889), in his list of Mexican meteorites,<sup>2</sup> gives the following information:—"The mass was found in 1871 at El Ranchito, 3 miles south-east of the mining centre Bacubirito, and measures 3·65m. long, 2·0m. broad, 1·50m. high: it is irregular in shape, and is traversed longitudinally by a fissure."

So extraordinary a mass, whether of meteoric origin or not, is worthy of careful study.

Bacubirito is in a direct line with Huejuquilla and El Valle, and is 127 miles south-west of the latter town.

### IV. STATE OF DURANGO.

As already shown, the large "Durango" mass, to the existence of which public attention was directed by Humboldt, is identical with one now

<sup>1</sup> *Proc. Ac. Nat. Sc. Philad.*, 1876, p. 122.

<sup>2</sup> *Cat. Des. cit.*, p. 5.

situated in a corner of the hacienda of San Gregorio, near Parral, in the State of Chihuahua. Several comparatively small masses of meteoric iron, however, have been found in the present State of Durango.

### 1. The La Plata mass.

This was mentioned in the *Gazetas de México* for 1802,<sup>1</sup> a year before Humboldt's arrival in Mexico: the account is as follows:—

“In the Sierra Madre, at a distance of 13 or 14 leagues from Durango City, some farm-labourers have found a mass of metallic iron weighing upwards of 11 arrobas (275 lbs.): its shape was that of two moderate-sized troughs joined together at one end: it was about three inches thick in the middle: the grain appeared to be at all parts the same: the internal concavity was wholly covered with inequalities, such as are made by the feet of a big dog in moist earth. After it had been divided with much labour into two pieces at the place of junction, one of them was worked in the forge and a ploughshare made of it. It was found to plough as satisfactorily as one made of ordinary iron. From inquiry made of Don Pedro del Pozo, at the place of the discovery, we learn that it was found about 500 yards north-east of the hill called La Plata.”

The second half of the mass, like the first, has disappeared.

La Plata is not indicated on any available map, but being in the Sierra Madre must be on the western side of the city.

### 2. The Guadalupe and Cacaria masses.

#### A. The Guadalupe masses.

##### a. A mass mentioned by Karawinsky.

A fragment of meteoric iron was acquired in 1834 from Freiherr von Karawinsky for the Vienna Collection: he had brought it with him from Mexico, and according to his statement to Partsch<sup>2</sup> it had been severed from a mass which weighed several hundred pounds and lay in the plain north-east of Durango. There is no statement that Karawinsky had himself seen the original mass: nor does he mention the distance from Durango City.

*The Karawinsky mass was found on the Guadalupe Estate.*

We have already seen that Weidner, when discussing the Mercado,

<sup>1</sup> Vol. 11, p. 1.

<sup>2</sup> *Die Meteoriten zu Wien*, 1843, p. 113.

remarked in 1858 that the fragments given to Humboldt as Durango iron might very well have been brought from Durango and at the same time have been either got from the "Labor de Guadalupe, an estate near Durango City," or from one of the two big masses which were lying at "Concepcion and Rio Florido."

We infer that in 1858 it was regarded by Weidner as a recognised fact that metallic iron, not comparable in size with the Chihuahua masses, had been really found at the Labor de Guadalupe: a search for a definite statement of the discovery of metallic iron on that estate has been unsuccessful.

But I am informed by Dr. Carlos Santa Maria of Durango that the above extensive estate begins at five leagues north-east of the city; and this is the very direction which was assigned by Karawinsky for the locality of the mass of which he sent fragments to Vienna in 1834: hence it is extremely probable that the Karawinsky mass is the one which Weidner had in mind, when in 1858 he referred to the iron of the Labor de Guadalupe. No other record of the discovery of a Durango mass on the eastern side of the city before 1858 can be found.

*b. A mass found at the rancho of La Pila.*

A mass weighing 46·4 kilograms was turned up by a plough in 1882 at the rancho of La Pila,<sup>1</sup> nine leagues east of Durango. Dr. Carlos Santa Maria sends me the information that the rancho is part of the estate called La Labor de Guadalupe, which begins 5 leagues north-east of Durango and extends as far as La Pila, close to the hacienda of La Punta shown in Garcia Cubas' map as 10 leagues south-east of Durango.

On analysis by Dr. Janke (1884), the following results were obtained:—

Iron	...	...	...	91·78
Nickel	...	...	...	8·35
Cobalt	...	...	...	0·01
Phosphorus...	...	...	...	traces
Carbon	...	...	...	traces
				100·14

The specimen is now in the British Museum Collection.

Confirmation of the above suggestion as to the site of the Karawinsky mass is found in the statement of Brezina, that the etching figures of the mass are identical with those of the one ploughed up at La Pila.

<sup>1</sup> *Abhandl. Natur. Ver. zu Bremen*, 1884, vol. 8, p. 513.

### B. The Cacaria mass.

(a.) According to Castillo<sup>1</sup> (1889) this is a nearly round mass weighing 41·4 kilograms. It had been in use as an anvil by a blacksmith of Durango, according to whom it had been brought from the "plains of the hacienda of Cacaria." The hacienda of Cacaria is on the highway from Durango to Chihuahua, and is about 10 leagues, as the crow flies, north of the former city. The mass was presented by the late Gerando Ruiz to the Mexico Museum and is now preserved there.

Dr. Carlos Santa Maria tells me that the mass was in use at the forge for several years, and was sent to Mexico before 1870.

(b.) Tarayre<sup>2</sup> (1867) mentioned a block of iron, weighing about 200 kilograms, in use as an anvil by a smith in Durango City, and said to have been found in the neighbourhood. Tarayre does not state that he himself saw the mass: his statement, like that made by him at the same time relative to the (non-existent) mass "three-fourths buried in the plain," may be based on hearsay, and the estimate of the weight be very inaccurate.

No one claims to have seen two masses in use as anvils at Durango.

The distance, measured in a direct line, from the hacienda of Cacaria to the above-mentioned La Punta is 14 Mexican leagues (36 miles). But the actual dispersion of the Cacaria and Guadalupe masses may have been much less, for the plains are on the eastern or Guadalupe side of the hacienda of Cacaria, and the Guadalupe masses have been found on the Cacaria side of La Punta.

Though the Cacaria and Guadalupe masses have not yet been compared as regards their etching figures, there is every probability that they belong to a single and not very widespread fall.

### 3. The Mezquital mass.

A mass weighing about 7 kilograms was brought from Mexico, shortly before 1868; it was said to have come from San Francisco del Mezquital.<sup>3</sup> One of the districts into which the State of Durango is divided is called Mezquital: but the name San Francisco del Mezquital is not to be found on recent Mexican maps, and as San Juan del Mezquital and San Miguel de Mezquital are shown in Cubas' map as situated in the adjoining State of Zacatecas, it began to be doubtful as to whether San Francisco del

<sup>1</sup> *Cat. Des. cit.*, p. 5.

<sup>2</sup> *Archives de la Commission Scientifique du Mexique*, 1867, Paris, vol. 3, p. 270.

<sup>3</sup> *Comptes Rendus*, 1868, vol. 66, p. 573.



Mezquital was in Durango at all. In an older map,<sup>1</sup> however, it appears as the name of the capital of the district of Mezquital, and is thus the town now called Mezquital : Dr. Carlos Santa Maria informs me that the elongated name San Francisco del Mezquital was used in the writings of the missionaries.

On analysis by Damour (1868) the following results were obtained :—

Iron	...	...	...	93·38
Nickel	...	...	...	5·89
Cobalt	...	...	...	0·39
Phosphorus...	...	...	...	0·23
				99·89

The main portion (7,513 grams) of the specimen was acquired for the British Museum Collection.

#### 4. The Bella Roca mass.

A mass weighing 33 kilograms was found on La Bella Roca,<sup>2</sup> a peak of the Sierra de San Francisco, near to Santiago Papasquiaro : that town is 85 miles, in direct line, north-west of Durango City. The existence of the mass became known to Professor Ward in 1888, but he could obtain no information as to the date of the original discovery or the name of the discoverer.

On analysis by Whitfield (1889) the following results were obtained :—

Iron	...	...	...	91·48
Nickel	...	...	...	7·92
Cobalt	...	...	...	0·22
Phosphorus	...	...	...	0·21
Sulphur	...	...	...	0·21
Carbon	...	...	...	0·06
				100·10

The specimen has been cut into slices and distributed.

*Masses from Durango belong to different types.*

The Mezquital mass, on etching, is seen to differ completely from those of Pila and Bella Roca. Specimens of the three masses now in the

<sup>1</sup> *Bol. Soc. Mex. de Geog. y Estad.* Primera época, 1858, vol. 6, p. 374.

<sup>2</sup> *Amer. Jour. Sc.*, 1889, ser. 3, vol. 37, p. 439.

British Museum were etched simultaneously: the octahedral structure of the Pila mass is so well defined that it could be traced on the polished face even before the etching; immediately after the application of the bromine-water, Widmanstätten figures manifested themselves on the faces of both Pila and Bella Roca, whereas no distinct figures could be seen on Mezquital even after prolonged action. After being washed and dried, however, the Mezquital face, though almost wholly dull, was seen to be still lustrous along straight parallel lines running completely across the face (130 mm. by 70 mm.) at intervals of one or two millimeters from each other: in fact, the etched face approximates in character to that of a Coahuila mass. This result is not inconsistent with the description of a face of small area by Daubrée, but is in complete disaccord with that of the etched face of a small fragment (149 grams) at Vienna.<sup>1</sup> Though meteoritic masses often vary in different parts, it seems more likely in this case that the Vienna specimen, which was acquired in 1872, had a wrong locality assigned to it, for with the exception of a fragment (170 grams) removed by Daubrée for the Paris Collection, the whole of the Mezquital mass is understood to have passed into the possession of the British Museum (7,513 grams) in 1870; and no fragment of this meteorite has ever been exchanged to Vienna.

Bella Roca is completely different in aspect from Pila, both in its enclosures and in the character of the Widmanstätten figures.

## V. STATE OF SAN LUIS POTOSI.

Meteoric iron has been brought from only two parts of the State of San Luis Potosi, namely Catorce and Charcas: as shown below, it is not at all impossible that the Charcas mass was transported to that town from the neighbourhood of Catorce.

### 1. The Catorce masses.

Three specimens are known to have been found quite near to Catorce and it may be assumed that they are products of a single meteor: they are:—(a) *the Descubridora mass, which is identical with the "Venagas" mass of Lawrence Smith*, (b) *a small mass seen by Burkart before 1834, but which has since disappeared*, (c) *a mass found in 1885*. Further (d) *Real del Guangoche*, and (e) *Hacienda of Agua Blanca*, have been mentioned as localities for metallic iron.

<sup>1</sup> *Die Meteoriten-Sammlung in Wien* (Brezina), 1885, p. 60.

(a) *The Descubridora mass.*

This mass, weighing 576 kilograms, now in the National Museum of Mexico, is stated to have been found between 1780-3.<sup>1</sup> Until 1773, when silver (the Descubridora vein) was accidentally discovered at the summit of the mountain-ridge close to the present town of Catorce, the district was quite uninhabited except by unsubdued Indians: within three years there was a population of 5,000, and by the year 1826 the population of the district amounted to 26,000.<sup>2</sup> To the east of the Sierra de Catorce the descent to the coast commences almost immediately, while to the west there is no ridge intervening between Catorce and Zacatecas. In 1773 the Sierra was covered with forests, but before 50 years had passed away not a tree or a blade of grass was to be seen. It thus seems likely that the large mass was found at the time when the careful examination of the mountain close to the present town of Catorce was made. After discovery, the mass was first moved to the hacienda of Poblazon, and was still there when Burkart was at Catorce in 1830, though he was unable to go to see it: it was next taken to the amalgamation works at San Miguel, near Catorce, to be used as a base for the ore-crushing stamps: it was then removed to the hacienda of Tanque de Dolores, and afterwards taken back to San Miguel; finally, it was purchased by Irizar, and presented by him in 1871 to the Society of Geography and Statistics of Mexico.

*The mass of " Venagas " is identical with that of Descubridora.*

In 1855 Lawrence Smith<sup>3</sup> wrote as follows:—

“Lieutenant Gouch (*sic*) also states that the intelligent but almost unknown Dr. Berlandier writes in his Journal of the Commission of Limits that at the hacienda of Venagas (*sic*) there was (1827) a piece of iron that would make a cylinder one yard in length with a diameter of 10 inches. It was said to have been brought from the mountains near the hacienda. It presented no crystalline structure and was quite ductile.”

Smith refers in his later papers to the same statement without any variation of the details. Burkart<sup>4</sup> tried repeatedly and unsuccessfully to obtain information as to the locality of the hacienda; he remained under the impression that it was somewhere between the cities of Durango and

<sup>1</sup> *Bol. Soc. Mex. de Geog. y Estad.*, México. Segunda Época, 1872, vol. 4, p. 319. *La Naturaleza*, México, 1871-3, vol. 2, p. 290. *Cat. Des. cit.* (Castillo), p. 4.

<sup>2</sup> *Lib. cit.* (H. G. Ward), vol. 1, pp. 457, 471; vol. 2, pp. 232, 249, 259.

<sup>3</sup> *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160; 1869, ser. 2, vol. 47, p. 383.

<sup>4</sup> *Neues Jahrbuch für Min.*, 1858, p. 770; 1870, p. 691.

Chihuahua. Brezina thought the mass might be one of the Coahuila group, and further suggests a theory which rests upon the assumption that the mass was actually cylindrical.<sup>1</sup>

In the first place "Gouch" is a mistake for "Couch," as already indicated. In the next place, Couch acquired for the Smithsonian Institution<sup>2</sup> all the voluminous manuscripts of Dr. Berlandier, who had died in 1851: hence it seemed possible that Couch might have obtained the above information from a hitherto unpublished record.

After a tedious search Berlandier's statement was at length traced: it was found on page 50 of the "*Diario de viage de la Comision de Limites—Lo Escribieron*—L. Berlandier y R. Chovel: 1850. 4to," and literally translated, runs as follows:—

"December 22, 1827. From the mining centre of Catorce to the hacienda of Vanegas (*sic*).

"On December the 22nd we set out from Catorce to rejoin the companions whom we were expecting to meet at Vanegas, six leagues distant in a north-east direction.

"Near the hacienda of Poblacion (*sic*) is a mass of iron from which could be made a cylinder a yard in height and ten inches in diameter. No part of its surface shows any sign of crystallisation: its edges are well rounded and the iron is very ductile. We had great difficulty in severing some fragments: before ourselves, two Englishmen, provided with good tools and manual assistance, had spent a whole day in cutting off some pieces which were really not very large. We were told that the mass had been brought a distance of some leagues, but we did not hear from what point nor the mode of occurrence. The people on the estate believe that the mass is insensibly moving in a direction from north to south. We vainly used our little logic in opposition to this belief."

It is obvious that this is the authority cited by Couch, and that there has been a confusion between the hacienda of Poblazon (Poblacion), where the mass was lying, and the hacienda of Vanegas (not Venagas) to which Berlandier's party was travelling on that day.

On analysis by Murphy (1872)<sup>3</sup> the following results were obtained:—

<sup>1</sup> *Sitzungsber. Ak. Wien*, 1881, vol. 83, div. 1, p. 473.

<sup>2</sup> *Smithsonian Report for 1854*, pp. 15, 396.

<sup>3</sup> *La Naturaleza, México*, 1871-3, vol. 2, p. 290.

Iron	...	...	...	89.51
Nickel	...	...	...	8.05
Cobalt	...	...	...	1.94
Sulphur	...	...	...	0.45
Chromium	...	...	...	trace
Phosphorus	...	...	...	trace
				99.95

(b.) *A small mass seen by Burkart before 1834.*

When at Catorce in 1830 Burkart heard of the mass then at Poblazon,<sup>1</sup> but could get no information about other masses: somewhat later, when at Zacatecas, he saw a roundish mass, apparently complete and not a fragment, in the possession of an Italian named Chialiva: it must have weighed 10 or 12 lbs. and was said to have been got at Catorce.<sup>2</sup> The mass has not been heard of since: Burkart lived at Zacatecas from 1828 to 1834.

(c.) *A mass found in 1885.*

A mass weighing 92 lbs. was found by a miner near Catorce in 1885,<sup>3</sup> and is now in the collection of Mr. Kunz. It must have been met with once before and thrown away, for on one side an opening  $3\frac{1}{2}$  inches long had been made, and a piece of a copper chisel had been left wedged in it: a long exposure was indicated by the partial oxidation of the copper. The copper was hardened by the ancient Mexicans by the addition of a small proportion of tin: recent analysis of one specimen proved the presence of 2.13 per cent. of the latter metal.<sup>4</sup>

On analysis of the iron by Mackintosh (1887) the following results were obtained:—

Iron	...	...	...	90.09
Nickel and Cobalt	...	...	...	9.07
Phosphorus	...	...	...	0.24
Schreibersite	...	...	...	0.60
				100.00

<sup>1</sup> *Neues Jahr. für Min.*, 1856, p. 286; 1857, p. 54.

<sup>2</sup> *Ibid.*, 1856, p. 286.

<sup>3</sup> *Amer. Jour. Sc.*, 1887, ser. 3, vol. 33, p. 233.

<sup>4</sup> *Anales del Museo Nacional de México*, 1877, vol. 1, p. 117.

The above are the only masses from Catorce of which there is definite information; but the occurrence of iron at two other places in the immediate neighbourhood, namely, Real del Guangoche and Agua Blanca, was mentioned at the beginning of the century.

(d.) *Real del Guangoche, near Catorce.*

Del Rio<sup>1</sup> merely specifies "Real del Guangoche, close to Catorce" as a locality for native iron: he does not describe the specimens or the mode of occurrence: he mentions no other locality near Catorce, nor does he record even the existence of the mass at Charcas. No further mention of the Real del Guangoche has yet been traced, and we are thus ignorant of its precise locality: probably the statement really refers to the discovery of the Descubridora and Charcas masses; for it would be unlikely that news of the discovery of small specimens, now lost, should have been sent to Del Rio, and that information about the large masses, found many years before that date and still preserved, should have failed to reach him in Mexico City.

(e.) *Agua Blanca, near Catorce.*

Del Rio gives the following both in his *Tablas Mineralógicas* (p. 57) and in his *Elementos de Orictognosia*:<sup>2</sup>—

"Coeto and Cotero assert that iron occurs in bands (*cintas*), one or two inches thick, in conglomerate above the hacienda of Agua blanca (*sic*) near Catorce. I hope some other pupil will send a piece to the college, and thus confirm the existence of terrestrial metallic iron, as announced by Lehmann for the locality of Eibenstock in Saxony. The facts as yet established, however, seem rather to confirm the (meteoric) theory of Chladni."

Del Rio clearly considered the supposed mode of occurrence to require verification: nothing has since been heard of it and the exact position of Agua Blanca seems to be now unknown.

It may be remarked that it has since been established that the Eibenstock (or Steinbach) specimen, referred to above, is itself of meteoric origin.

## 2. The Charcas mass.

Sonnenschmid, who according to his preface had spent 12 years in Mexico, states in his work, published in 1804:<sup>3</sup>—

<sup>1</sup> *Tablas Mineralógicas*, México, 1804, p. 57.

<sup>2</sup> *Segunda Parte*, 1805, p. 40.

<sup>3</sup> *Lib. cit.*, p. 288.

“At the corner of the churchyard (*church*, according to Burkart) at Charcas, there stands a half-buried block of native iron: the part above the surface is about  $2\frac{1}{2}$  feet long and 1 foot thick. It is said that the mass was brought from the neighbourhood of San José del Sitio, an estate 12 leagues distant, and that in the same neighbourhood several other masses have been seen firmly embedded in a limestone-like rock.”

No one has yet been able to determine the position of this estate: the name itself is an odd one; the extent of a Mexican estate was at that time generally expressed in *Sitios*, a *Sitio* being a square-league, and San José del Sitio thus differs from most of the Mexican names in being without any obvious meaning. In the time of Ward (1825-7) most of the haciendas of San Luis Potosi were vast sheep-walks.<sup>1</sup> If the estate lay in a direction north of Charcas, it would be near to Catorce, for the distance between the two towns is only 17 Mexican leagues.

Burkart<sup>2</sup> says (1857):—“I am informed relative to the occurrence of meteoric iron in the vicinity of Catorce and San Luis Potosi that it appears as if great quantities occur there on the limestone at the summit of the range, partly in big masses like those of Descubridora and Charcas, partly in masses of the size of the fist and smaller.

An approximate analysis by Meunier<sup>3</sup> (1869) gave the following results:—

Iron	...	...	...	98·01
Nickel and Cobalt	...	...	...	4·32
Residue	...	...	...	0·70
				98·03

The Charcas mass was taken possession of by the French in 1866, and is now preserved in the Paris Collection: according to the Paris List, the weight is 780 kilograms.

*Possible identity of original locality of the Catorce and Charcas masses.*

The Descubridora mass found in 1780-3, the one found in the same district in 1885, and that of Charcas, all show excellent Widmanstätten figures when etched: and though there are minor differences of character, they are only such as we might expect to meet with in small etched faces on different parts of even a single large mass. The figures, so far as it has yet been practicable to determine them, while insufficient to establish

<sup>1</sup> *Lib. cit.*, vol. 2, p. 228.

<sup>2</sup> *Neues Jahrb. für Min.*, 1857, p. 54.

<sup>3</sup> *Géologie Comparée; Étude sur les Météorites*; par S. Meunier, Paris, 1867, p. 40.

either the simultaneity or the multiplicity of the falls to which the above masses belong, are not at all inconsistent with the view that the masses form a single group.

But when we remember that the removal and the original locality of the Charcas mass were still unforbidden at the time of the visit of Sonneschmid (1792-1804), and that the history of meteoritic masses passes into speedy oblivion whenever there is delay in publishing the record, we may fairly infer that the Charcas mass was found about the same time as that of Descubridora (1780-3); and probably in the vicinity of Catorce, since a careful search for silver-veins was made in the whole district after the discovery of the riches adjacent to Catorce itself: Sonneschmid says that the Charcas mass had been got from a place where several other masses had been seen, and Del Rio only specifies the neighbourhood of Catorce for San Luis Potosi iron: at the time of Ward's visit (1825-7) there was a good carriage-road from Charcas to Catorce,<sup>1</sup> and the transport of the large mass from the Catorce district to the church at Charcas would present no practical difficulty. Although Sonneschmid visited and described the mines of Catorce, the discovery of the Descubridora or other masses of iron in the immediate neighbourhood is unmentioned by him, unless the estate referred to as San José del Sitio was really in that region.

Taking everything into consideration, it is not improbable that all the masses yet found in the State of San Luis Potosi belong to a single fall, and have been met with in a district of no extraordinary area.

#### *Specimen in the Poinsett Collection.*

The specimen taken to the United States by Poinsett<sup>2</sup> and supposed by Smith to be possibly from Charcas, is probably a Toluca specimen, as shown below.

#### VI. STATE OF ZACATECAS.

Only one mass has been found in this State.

#### **The Zacatecas mass.**

The first known mention of the Zacatecas mass was made in the *Gazetas de México* for 3rd April, 1792, p. 59 :—

<sup>1</sup> *Lib. cit.*, vol. 2, p. 232.

<sup>2</sup> *Amer. Jour. Sc.* 1868, ser. 2, vol. 45, p. 77.



“From time immemorial there has been in the old St. Domingo Street of the city of Zacatecas a stone half-buried in the ground, which has been called Iron-stone by reason of its solidity. As to its origin there is only an oral tradition that it was found by one of the first colonists when working the Quebradilla mine, and has been lying near the door of his house ever since: it was noticed there by Sonneschmid, and recognised by him as native iron and recommended to the attention of the Government. Don Fermin Apecechea had it taken to his house and weighed: the weight was found to be 2,000 lbs. The mass is somewhat more than  $1\frac{1}{2}$  yards long, not so much in breadth, and somewhat over a quarter of a yard in thickness.”

On page 155 of the same volume of the Gazette is published a letter of Sonneschmid, dated 24th July, 1792, which relates to the mass.

According to Burkart, the Quebradilla mine on the western outskirts of the city was worked immediately after the conquest of Mexico by the Spaniards.<sup>1</sup>

In 1804 Sonneschmid described the iron, but gave no history, simply stating that “no probable guess can be given relative to the origin of this remarkable specimen.” Burkart lived at Zacatecas in the years 1828-34:<sup>2</sup> the mass was then in a private house, the residence of Don Angel de Abille in Tacuba Street. Burkart quotes at length the above statement from the *Gazetas de México* of 1792, but adds that at the time of his own residence at Zacatecas, there was one tradition that the mass had been brought “from the north,” and another “that the mass was at Zacatecas when the Spaniards reached there.”

Castillo (1889)<sup>3</sup> says that the specimen was “formerly in a street of the city of Zacatecas, and was afterwards removed to the hacienda of Cieneguillas, which belongs to the Gordoia family. It has the shape of a parallelepiped, and is 1.06 m. long, 0.50 m. broad, and 0.25 m. thick.”

*The mass mentioned by Cavaroz.*

Writing from Durango on 21st September, 1864, Dr. Cavaroz says:<sup>4</sup>—

“We may note the existence of large fossils at a certain place called Los Zapotes, four leagues from Cuquio. At a very fine hacienda, at which

<sup>1</sup> *Reisen in Mexico* (J. Burkart), Stuttgart, 1836, vol. 2. p. 58.

<sup>2</sup> *Neues Jahrb. für Min.*, 1856, p. 289.

<sup>3</sup> *Cat. Des. cit.*, p. 4.

<sup>4</sup> *Comptes Rendus*, 1864, vol. 59, p. 1099.

we made a general halt before reaching Zacatecas, there is a mass of iron which was found long ago in that city. A piece has been separated with great difficulty to be taken to England for study. The mass which remains may be 70 cm. long, 30 cm. broad, and 25 cm. thick, and has an irregular rectangular shape."

The specimen thus referred to is doubtless identical with the old Zacatecas mass; and the piece said to have been taken to England for study is probably the very one, weighing about twenty pounds, which had been analysed and described in London by Dr. Hugo Müller in 1859. The Gordo family have long owned fine estates near Zacatecas: according to Ward (1826),<sup>1</sup> they then had purchased the fine estate of Mal Paso near Zacatecas for 700,000 dollars, and had besides a fortune of a million dollars, acquired from the La Luz mine at Catorce which began to yield returns in 1806; there is a hacienda bearing the name Cieneguilla between Cuquio and Zacatecas.

On analysis the following results have been obtained by Dr. C. Bergemann<sup>2</sup> and Dr. Hugo Müller<sup>3</sup> respectively:—

	Bergemann.		Müller, 1859.		
	1849. I.	1857. II.	I.	II.	III.
Iron .. ..	85.09	85.42	89.84	91.30	90.91
Nickel .. ..	8.00 <sup>4</sup>	9.73	5.96	5.82	5.65
Cobalt .. ..	0.67	0.44	0.62	0.41	0.42
Phosphorus .. ..	..	..	..	0.25	0.23
Sulphur .. ..	0.84	..	0.13	..	0.07
Silica .. ..	..	..	..	..	0.50
Copper .. ..	0.03	..	trace	trace	trace
Magnesium .. ..	0.34	..	trace	trace	trace
Residue .. ..	3.65	1.05	3.08	2.19	2.72
	98.62	96.64	99.63	99.97	100.50

## VII. STATES OF MEXICO AND MORELOS.

### The Toluca group.

Masses of iron have been brought from various localities in the States of Mexico and Morelos: it seems likely that everyone of them was originally found in the immediate neighbourhood of Xiquipilco, a small town four leagues due east of Ixtlahuaca, in the State of Mexico.

<sup>1</sup> *Lib. cit.*, vol. 1, p. 471.

<sup>2</sup> *Pogg. Ann.*, 1849, vol. 78, p. 406; 1857, vol. 100, p. 256.

<sup>3</sup> *Quart. Journ. Chem. Soc.*, 1859, vol. 11, p. 236.

<sup>4</sup> *Pogg. Ann.*, 1849, vol. 78: p. 410, says 7.999; table on p. 412, says 9.895: the sum of the given percentages is not 99.348 as there stated, but 100.348.

So much has been written relative to this iron that it will be convenient to collect together the few original statements which relate to the actual discovery of the masses (Plate II.).

(1784.) "Æ" says :—In the town of Xiquipilco, belonging to the District of Ixtlahuaca, native metallic iron is met with so pure that, without any other preparation than heating, it may be worked into any shape ; as I have verified in two journeys, undertaken with the object of discovering if there were veins of this mineral, which would be of infinite utility : but my observations only verified that masses of various shapes and sizes are found scattered through the fields, and that the Indians keep a look out for them, though the iron is at first covered with a crust of ochre. The Indians of the town and the owners of the haciendas use no other for the fabrication of the necessary agricultural implements."

(1804.) Del Rio<sup>2</sup> gives the following as Mexican localities for native iron :—"Zacatecas, Real del Guangoche near Catorce, Province of Durango, near Cuernavaca in Xiquipilco, and in the Misteca."

(1811.) Humboldt,<sup>3</sup> who had been in Mexico in 1803-4, says :—"It is to Sonneschmid that we are indebted for a knowledge of the meteoric iron which is found at several places in Mexico—for example, at Zacatecas, Charcas, Durango, and if I am not mistaken, in the vicinity of the small town of Toluca."

(1826.) Wilhelm Stein,<sup>4</sup> in a letter of 23rd April, 1825, published by Nöggerath, says :—"I send a piece of native iron from Xiquipilco. The occurrence of this iron deserves a closer investigation ; so far practically nothing is known ; and on my first journey to Xiquipilco I did not succeed in clearing the uncertainty away, for notwithstanding my careful searches I was not fortunate enough to find a piece *in situ*. It is well known that a considerable quantity has been found in the neighbourhood during ploughing, and that it has been used for the manufacture of all kinds of implements."

(1831.) Alzate Ramirez<sup>5</sup> reported as follows :—

"From time immemorial, no iron has found its way to the town of Xiquipilco and to the neighbouring haciendas for the necessary purposes. The Indians of Xiquipilco collect what they can, for it is not abundant : the owners of the haciendas of Indege and Santa Isabel barter for it with the

<sup>1</sup> *Gazetas de México*, Wednesday, 15th Dec., 1784, No. 25, p. 201.

<sup>2</sup> *Tablas Mineralógicas*, México, 1804, p. 57.

<sup>3</sup> *Essai cit.*, vol. 2, p. 582.

<sup>4</sup> *Schweigger's Journal für Chemie und Physik*, 1826, vol. 47, p. 74.

<sup>5</sup> *Gacetas de Literatura de México*, por D. Jose Alzate Ramirez, Puebla, 1831, vol. 2, p. 381.

Indians who chance to find it, generally at the beginning of the rains, when it becomes visible among the soil. The Indians of Xiquipilco make spades and axes of the iron, and the owners of the said haciendas use it for ploughs. About the year 1776, I went to Xiquipilco to see with my own eyes the famed native iron. I found two smiths established in the town who worked the native iron : in my sight they forged it and worked it into the shape demanded of them.

(1855.) Dr. Krantz<sup>1</sup> stated at Bonn on 8th March, 1855 :—"I received from Mexico last autumn four masses of meteoric iron which had come from the following places, said by him to be in the Valley of Toluca :—a 43 lb. mass from Tejupilco, masses of 26 and 6 lbs. from Ocatitlan, and a 19 lbs. mass from Ixtlahuaca."

(1856.) Gustav A. Stein,<sup>2</sup> brother of the above mentioned Wilhelm Stein, reported as follows :—

"Having heard that the iron was found at various places in the Valley of Toluca, I went myself in July 1854 to get definite information at the small town of Ixtlahuaca : thence I was directed to the hacienda Mañi, a league north of the Indian village of Xiquipilco. In the barn of the hacienda there was a mass of iron weighing 220 lbs. : its owner told me that it had been found about 15 years before, half a league south of Xiquipilco, among the rounded pebbles of a small brook, which even in rainy weather contains little water : close by, though not in the brook itself, was found a 5½ lb. mass. A third of a league east of this locality a mass weighing some 300 lbs. had been found about twenty years before my visit. Another mass, weighing 19½ lbs., had been found a quarter of a league north-east of Mañi : one also was found three-eighths of a league east of Mañi. I was told that in times now remote large masses had been found as far away as the hacienda Mayorazgo. Some old landowners, in the neighbourhood of Ixtlahuaca, told me that knowledge of these masses of iron had been got long ago from a smith who had worked them into ploughshares and axes without using steel. The Indians of the neighbourhood for the sake of a small reward used to search for the pieces, which were then forged in his smithy. The masses, whether large or small, are now become scarce. But in the course of years a large quantity must have been worked up or taken away. They were carried as merchandise to various places, whence it happens doubt-

<sup>1</sup> *Sitzungsb. d. niederrhein. Gesell. f. Natur. und Heilkunde zu Bonn*, 1855, p. xlvii.

<sup>2</sup> *Sitzungsb. d. k. Ak. der Wissensch., Mathem.-Naturw. Classe*, 1856, Wien, vol. 20, p. 218.

less that masses of meteoric iron, though in each case originally got at Xiquipilco, have been known also under the names—Ixtlahuaca, Tepetitlan, Mayorazgo, Gavia and Toluca. A meteoric iron has lately been described as from 'Tejupilco in the Valley of Toluca.' I have no doubt that Tejupileo is a mistake for Xiquipilco. The town of Tejupileo is not in the Valley of Toluca; the town is well known to me, for it is only 9 leagues west of Arcos where I lived; and I have never heard of any find of iron in its neighbourhood. The specimens described by Dr. Krantz are certainly from Xiquipilco."

(1856.) Burkart<sup>1</sup> reported:—"I was told, when I dwelt in the neighbourhood, about 30 years ago, that the locality was Toluca, but I could get no meteoric iron there: I did not learn till later, when I was living at Zacatecas (1828-34), that the iron was really found at Xiquipilco, but in spite of all my efforts, I was not able to get a specimen of it. \* \* \* I think Tejupilco is a mistake for Xiquipilco. I cannot venture to decide whether the specimens said to have been got from Ixtlahuaca and Ocatitlan were actually found there or were only purchased there: I am inclined to think the latter must have been the case."

(1857.) Krantz<sup>2</sup> reported that a special search had been made in the Valley of Toluca in 1856 at his request: no fewer than 69 masses were found and sent to him, but the heaviest only weighed  $1\frac{3}{4}$  kilos., and the total weight was only  $49\frac{1}{2}$  kilos.

(1858.) Von Babo<sup>3</sup> analysed a fragment of a specimen which weighed 237 grammes: according to Schleiden of Trojes in Mexico "it came from the neighbourhood of Sizipilec, in the Valley of Toluca, where similar pieces are found distributed over a considerable area, and are frequently turned up by the Indians when ploughing."

(1889.) Castillo,<sup>4</sup> in giving a list of the specimens preserved in the Mexico Collection, states as follows:—

"1. Meteorites of a single fall found at *San Juan de Xiquipilco*, in the Valley of Toluca, State of Mexico.

(a) Meteoric iron of *Ocotlan*; small fragment.

(b) Meteoric iron of *Tenango*; small fragment.

(c) Meteoric iron of the *Cerro de Santiago*, near the hacienda of Gavia; small fragment.

<sup>1</sup> *Neues Jahrbuch für Mineralogie*, 1856, p. 299.

<sup>2</sup> *Pogg. Ann.*, 1857, vol. 101, p. 152.

<sup>3</sup> *Ber. über die Verhandl. d. naturf. Gesellschaft zu Freiburg i. B.*, 1858, vol. 1, p. 256.

<sup>4</sup> *Cat. Des. cit.*, p. 3.

(d) Meteoric iron of the *Sierra de Monte-Alto*, District of Xiquipilco ; small fragment.

(e) Meteoric iron of the hacienda of *Mañi*, District of Ixtlahuaca ; small fragment.

It is in the neighbourhood of Xiquipilco that the largest number of fragments of every dimension have been found : some reach a weight greater than 45 kilos. The inhabitants discover these fragments either in the fields when ploughing, or in the ravines hollowed by the passage of the water after heavy rains.

2. Meteorite of *Ameca-Ameca*, State of Mexico. It is a small nodule of meteoric iron found in the town of Ameca-Ameca. It is in the National Museum of Mexico.

3. Meteorite of *Los Amates*, State of Morelos. It is a nodule of iron which was found among several specimens of iron-minerals brought from the rancho of Los Amates, on the road from Mexico to Iguala and in the neighbourhood of the latter place.

4. Meteorite of *Cuernavaca*, State of Morelos. It is a fragment of meteoric iron found, so it is said, on the road from Mexico to Cuernavaca, in the mountains. It is in the National Museum of Mexico."

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We may remark, with Chladni, that the shower of iron must have fallen before, probably long before, the arrival of the Spaniards, or there would have been some surviving tradition of the occurrence, for the Valley of Toluca has been inhabited from time immemorial : the meteor of 1521, already referred to, is not known to have yielded any tangible material. Hence the time during which the masses have been known as desirable objects for smithy-work is also probably very long : the forging of them into agricultural implements was already in full swing about 1776 : they were then regarded as a terrestrial product. Stein distinctly states that they were articles of merchandise, and were taken for sale to various towns in the neighbourhood. And it is worthy of mention, that in the only cases in which names of places not immediately near to Xiquipilco are attached, the early history of the specimens cannot be traced. Further, those who have inquired into the occurrence in the neighbourhood itself could only hear of discoveries having been made within a few miles of Xiquipilco ; in fact, for the first 50 years after the visit of Alzate Ramirez scarcely any other name is mentioned. Stein was in the neighbourhood of Toluca at the time when the specimens said to have been got from Ocatitlan, Tejupilco and Ixtlahuaca, were sent to Krantz in Germany, and asserts that the original locality was certainly Xiquipilco.

Del Rio (1804), who was living in Mexico City, it is true, cites a Mexican locality "near to Cuernavaca in Xiquipilco," but such a statement, as it stands, is unintelligible. Cuernavaca is farther from Xiquipilco than from the capital where Del Rio was located : as the crow flies, Cuernavaca is 52 miles from Xiquipilco, while each of those places is only 35 miles distant from Mexico City. It is almost certain that Cuernavaca, which has long been a well-known place, is given by Del Rio in error for Ixtlahuaca ; and that it was intended to aid in specifying the approximate locality of the small Indian hamlet of Xiquipilco : in 1805<sup>1</sup> Del Rio incidentally referred to the masses of Xiquipilco without mentioning either Cuernavaca or Ixtlahuaca.

On the other hand, it is possible that a comma has been omitted during printing, and that the sentence as written by Del Rio was "*junto á Catorce, en Xiquipilco,*" thus indicating two distinct localities : Cuernavaca, however, was not again mentioned as a locality for metallic iron till 1889.

As regards the meteorites of Cuernavaca, Ameca-Ameca, and Los Amates, mentioned by Castillo in 1889, there is, in the first place, no evidence that they have been examined and found to be identical in character with those from Xiquipilco. In the second place, even if the identity of character is ever proved, there will remain the possibility that the fragments have been transported from the Valley of Toluca.

The valley from Cuautla to Cuernavaca is a very fruitful one, and at the time of Ward's visit (1825-6) was one succession of beautiful haciendas : probably many of the Xiquipilco fragments were carried over the mountains to be sold at the haciendas, either as curiosities or as material for the manufacture of agricultural implements.

The Ameca-Ameca meteorite "is said to have been found in that small town." Ameca-Ameca is a town where there are now iron-foundries, and where "ploughs, castings, smoothing irons, mill-wheels and other articles are manufactured : " the road from Mexico to the valley of Cuernavaca and Cuautla passes through it.

Similarly the rancho of Los Amates is on a line of traffic : according to Castillo it is near to Iguala and on the road from Mexico to that town. As the railway from Mexico to Acapulco was planned to pass through both Cuernavaca and Iguala, those towns must be on a natural route to the Pacific coast.

The Ocotitlan (of Krantz) is probably the town of Ocotitlan, five miles

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<sup>1</sup> *Elementos de Orictognosia* ; segunda parte, p. 40.

south-east of the town of Toluca, and not as Burkart supposed Xocotitlan or Hocotitlan 15 miles north-west of Xiquipilco.

Ocotlan (of Castillo) is probably a mistake for Ocotitlan, for the Sierra de Ocotlan is not in the State of Mexico at all, but on the south-western border of the State of Morelos and about 30 miles south of Cuernavaca.

Tenango (of Krantz) is the capital of its district, and is only nine miles south of the town of Toluca.

Sizipilec (of Von Babo or Schleiden) is not given in the maps: from Sizipilec to Xiquipilco is at first sight too vast a transition to be due to error of transcription or printing, but when written in German cursive hand, the two words present such a close similarity that there can be no doubt at all of the name Sizipilec having come into existence in that way: the German *X* has become *S*, *qu* has become *z*, *co* has become *ec*. In fact most of the Toluca specimens got into the market through Schleiden, as is stated by Stein: and his remarks relative to the mode of occurrence at "Sizipilec" are identical with those made in the case of Xiquipilco.

A similar transformation from Xiquipilco to Tejupileo (of Krantz) in German, is easily possible; and indeed a printed label, sent by Krantz with a specimen to the British Museum, is altered in Krantz's handwriting from Tejupileo to Xiquipileo, showing that he himself accepted the view expressed by Burkart that there was a mistake in his original version of the name.

*A Mexican specimen in the Poinsett Collection.*

A specimen found in Poinsett's collection of Mexican minerals was analysed by Lawrence Smith, who suggested that it might belong to the meteorite of Charcas.<sup>1</sup> Poinsett published notes of a journey made through Mexico in 1822, and was for some time the United States Representative at Mexico City.<sup>2</sup> Burkart saw the Charcas mass soon after Poinsett's journey, and there were then no marks indicating the removal of a fragment. Poinsett makes no mention of meteoric iron in the notes of his journey. Everything points to the specimen being really one of the small masses from the Valley of Toluca: we may add that a specimen of the Toluca iron was sent to the Berlin Collection from the Embassy at Washington.<sup>3</sup>

<sup>1</sup> *Amer. Jour. Sc.*, 1868, ser. 2, vol. 45, p. 77.

<sup>2</sup> *Notes on Mexico made in the Autumn of 1822* (Poinsett), London, 1825.

<sup>3</sup> *Beschreibung und Eintheilung der Meteoriten zu Berlin* (G. Rose), 1864, p. 60.



*Chemical Analyses of the Toluca iron.*

Numerous analyses of Toluca masses have been made ; the iron found by various chemists varies from 85 to 92 per cent. : a table of the results has been published by Buchner.<sup>1</sup>

## VIII. STATE OF OAXACA.

In this State a large mass has been found at *Yanhuitlan* : identical with this are masses said to have been found at *Chalco* and *Cholula* : fragments of the same mass are in the collections under the name of *Misteca*.

## 1. The Yanhuitlan mass.

*El Mosaico Mexicano*, 1840, vol. 3, p. 219, states :—

“The following is extracted from the information supplied by José Lopez Ortigoza, Governor of the Department of Oajaca. The town of Yanhuitlan is situated in the Misteca alta, at a distance of 4 leagues from Teposcolula. Near this town is a hill called in the Mistec language Deque-Yucunino : at its foot, according to the accounts of the oldest inhabitants, some Indian labourers, while tilling the ground, found an extraordinary mass, which from the rarity of its characters attracted their attention, and they carted it as far as the town : unable to learn its origin or value they tumbled it into a corner where it long remained. Its shape and hardness induced Vicente Hernandez, the blacksmith, to transport it to his smithy, and he used it as an anvil for some years. In 1825, A. F. Morney (*i.e.* Mornay), an Englishman, saw the mass, and not without much difficulty cut off a piece which he afterwards analysed and found to contain iron, nickel and silica. About the years 1826-30 it was removed from Yanhuitlan, and was to have been placed in the Museum of Oajaca : its great weight and the bad roads made the undertaking so difficult, that at a short distance from Yanhuitlan the plan was given up, and the mass was left there. In 1832 the present Bishop of Puebla saw it, and also had a little piece cut off.”

The mass, which weighed 421 kilos., was removed to the City of Mexico in 1864, and minutely described by Castillo and Rio de la Loza.<sup>2</sup>

## 2. The Cholula mass.

Buchner,<sup>3</sup> in the continuation of his meteorite-list, says in 1865 :—

<sup>1</sup> *Die Meteoriten in Sammlungen*, Leipzig, 1863, p. 141.

<sup>2</sup> *Bol. Soc. Mex. de Geog. y Estad.*, 1865, vol. 10, p. 661.

<sup>3</sup> *Pogg. Ann.*, 1865, vol. 124, p. 599.

“Cholula, Mexico. A meteoric mass of about 500 kilos. is said to have been just brought to the City of Mexico. From its weight it appears to be an iron meteorite. Further news is to be expected.”

It is obvious from the above history, that the mass referred to by Buchner is really that of Yanhuitlan, and that there has been a confusion of the names Cholula and Teposcolula: in fact, Buchner omitted the Cholula mass from his later list of 1869.<sup>1</sup>

### 3. *The Chalco mass.*

Burkart,<sup>2</sup> however, in 1870, gave a list of Mexican meteorites, and among them:—

“Chalco, a town in the Valley of Mexico. No further news has been received relative to the iron meteorite of 500 kilos. which, according to Buchner (*Pogg. Ann.*, vol. 200, p. 599), is said to have been taken to Mexico.”

Buchner's statement is really in vol. 124, p. 599, and relates to the mass called by him Cholula; vol. 200 had not at that time (1870) been published.

Hence Chalco is a mistake for Cholula, itself a wrong version of Teposcolula, and the Chalco mass is identical with that of Yanhuitlan.

### 4. *The Misteca Alta fragments.*

Del Rio<sup>3</sup> (1804) mentions “La Misteca” as a locality for metallic iron. According to Humboldt,<sup>4</sup> “the Province of Oaxaca includes two mountainous districts which have been known since the most remote times under the names Mixteca and Tzapoteca. The ancient Mixtecapan is now divided into Upper and Lower Mixteca (Mixteca alta and baja). The Indians of La Mixteca are an active, intelligent, industrious people.” As already stated, the town of Yanhuitlan is in Mixteca alta, and the large mass had been found long before Mornay noticed it in 1825.

In 1834, Partsch<sup>5</sup> acquired for the Vienna Collection a small piece of meteoric iron, and later stated as follows (1843):—

“From an Indian town in the Misteca, State of Oaxaca, Mexico. Relative to the existence of this meteoric iron nothing has hitherto been published. Freiherr von Karawinsky of Munich, who has repeatedly

<sup>1</sup> *Pogg. Ann.*, 1869, vol. 136, p. 605.

<sup>2</sup> *Neues Jahrbuch für Min.*, 1870, p. 692.

<sup>3</sup> *Tablas Mineralógicas*, p. 57.

<sup>4</sup> *Essai politique &c.*, vol. 1, p. 263.

<sup>5</sup> *Die Meteoriten zu Wien*, 1843, p. 134.

travelled about Mexico, brought the piece back with him. It was cut from a mass which lies in the above mentioned place, as he informs me by letter.”

It is clear that the mass referred to by Karawinsky must be identical with the one which at that date was still lying near the Indian town of Yanhuitlan.

Burkart,<sup>1</sup> having applied to Drusina for a specimen of the Misteca iron, received a fragment in 1855, but got no information as to the exact locality: Castillo (1889) says that he himself gave the specimen to Drusina to be sent to Burkart, and is of opinion that it may be the truncated point of the Yanhuitlan mass.

It is obvious that all the fragments known as Oaxaca or Misteca have been cut from the single mass found near the town of Yanhuitlan, and that the existence of the mass was already known in the Capital in 1804.

The following analyses have been published:—

	<i>Misteca.</i>		<i>Yanhuitlan.</i>	
	Bergemann. <sup>2</sup> 1857. S.G. 7·58	Rammelsberg. <sup>3</sup> 1869. S.G. —	Rio de la Loza. 1864. S.G. 7·82	Rammelsberg. <sup>3</sup> 1869. S.G. —
Iron ... ..	86·86	—	96·58	—
Nickel .. ..	9·92	4·39	1·83	6·21
Cobalt ... ..	0·74	0·18	0·36	0·27
Calcium... ..	—	—	0·61	—
Phosphorus ...	0·07	—	—	—
Sulphur ... ..	0·55	—	—	—
Residue ... ..	0·97	0·20	0·01	trace.
	99·11		99·39	

The results furnish another striking example of the impossibility of employing, for discriminatory purposes, percentage compositions assigned by different chemists on the basis of analyses made in different ways on different fragments of meteoric iron, which is always a more or less complex mixture of various chemical compounds: in the present case, the difference is doubtless chiefly due to the difference in the processes employed; Rio de la Loza called attention to the fact that some of the reactions, observed but not specified by him, were of so unexpected a character as to suggest the presence of an unknown substance.

<sup>1</sup> *Neues Jahrbuch für Min.*, 1856, p. 305.

<sup>2</sup> *Pogg. Ann.*, 1857, vol. 100, p. 246.

<sup>3</sup> *Zeitsch. d. deutsch. geol. Gesell.*, 1869, vol. 21, p. 83.

## IX. STATE OF GUERRERO.

**The Caparrosa mass.**

Castillo<sup>1</sup> in 1858, on breaking a piece of copper pyrites which had been brought from the Rincon de Caparrosa, south-west of Chilpancingo, State of Guerrero, found a nodule of metallic iron, weighing 341 grams, embedded in it. He reports that it shows Widmānstätten figures when etched, and that the copper pyrites occurs in a talc-schist.

A specimen discovered under such extraordinary circumstances, if really of meteoric origin, is worthy of a more minute examination and description.

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*Summary as regards the dispersion of Mexican iron masses.*

In each of the States of Zacatecas, Oaxaca and Guerrero, only a single mass of meteoric iron has been found, and there is absolutely nothing to suggest that they do not represent independent falls.

In Sinaloa, likewise, only a single mass has been met with, and its characters have not been determined: a suggestion of a relationship with another group would rest on the slight fact that the site of an extremely large mass is in a straight line with two other sites where large masses are now lying.

In San Luis Potosi two localities are recognised, but there is a strong probability that the Charcas mass, which has undoubtedly been transported to that town from a distance, was brought from the neighbourhood of Catorce: and, even if this was not the case, there is no evidence that the mineralogical characters are such as to render separate falls improbable.

In Durangó four or five distinct localities are known, but the characters of the only masses which have been examined point unmistakably to the falls of distant masses having been independent of each other.

In Mexico there has undoubtedly been a large shower of limited dispersion in the Valley of Toluca: the three remaining masses from Mexico and Morelos have not been examined, and are very small and portable: even if they have not been transported, they may be found on examination to present characters which will differentiate them from the masses of the Toluca shower.

From Coahuila many masses have been got, but it is extremely probable

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<sup>1</sup> *Cat. Des. cit.*, p. 1; *Verh. d. naturh. Vereines d. preuss. Rheinl. u. Westph.*, Jahrg. 22, Sitz. Mai 4, 1865, p. 72.

that all of them were brought from a single district of very small area : the two Nuevo Leon masses have never been examined and had obviously been transported, perhaps from Coahuila or San Luis Potosi.

In Chihuahua three or four areas are represented : but of the masses found in that State only those of the Huejuquilla group have been examined, and that in a very incomplete way : the recognition of the singleness of the fall of the Huejuquilla group depends almost entirely on the general similarity of appearance of the large masses. If the masses really belong to a single fall, as the available information makes most probable, the maximum dispersion is now 66 miles : but one of the terminal masses, that of San Gregorio, is known to have been transported by the Spaniards on one occasion for  $1\frac{1}{2}$  leagues, while according to a tradition current three centuries ago it had accompanied the Indians when they journeyed southward to take possession of that part of Mexico.

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The Index to the names of the more important persons and places mentioned in the foregoing pages will facilitate reference to the facts here collected together.

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