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ON
THE ELEMENTARY SUBSTANCES

ORIGINATING AND PROMOTING

CIVILISATION :

THROUGHOUT THE WORLD.

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BY PEDRO NISSER, ESQ.

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A Señora Mariano Ospina I.D.
Presidente de la República
de la
Nueva Granada.

Este Tratado es ofrecido
Con Sentimientos de la mayor Consideración
y estimación verdadera,

por

Su muy adicto Apreciador

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El autor
L. Vissery

FUNDACIÓN ANTIOQUEÑA PARA LOS ESTUDIOS SOCIALES
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*On the Elementary Substances Originating and Promoting Civilisation
throughout the World.* By PEDRO NISSER, Esq.

[Read before the Royal Society, 9th January, 1860].

[Our investigations into the abundant and varied stores of nature, when crowned with success, reveal facts, in the truth of which are reflected the simplicity and even sublimity of the means afforded by Providence for the furtherance of civilisation.]*

IN the brief view of "The Geological Distribution of Gold," which some months ago I had the honor of communicating to this Society, in referring to the Pleistocene Period of the tertiary epoch of geological arrangements, I stated—"That though it appeared our globe had attained that perfection which was required for the re-organisation of organic development, still the earth would in that state only have served the purpose of an irrational population (just as we see had been repeatedly the case during the foregoing epochs), but not for the intelligent being, who was not merely to master the animal tribes, but also to cultivate his own intellect. For this grand moral object certain material agencies were required and provided. The agency of water being again required, completion was thus given to the great and marvellous work.† This last accomplishment in creation, when viewing 'the first leaves' of the often 'mysterious stone book,' will reveal a surprising and satisfactory answer."—This answer I now propose to give. But I wish first for a moment to call your attention to a view of some of the prevailing notions of the most marked gradations of civilisation in general.

When we inquire into the aboriginal life of our own species, we find certain gradations in their material improvements, and we see how man, step by step, has proceeded from his state of nature along

* The word "civilisation" embraces the two distinct branches of culture, the mental and the moral, each of which has its subdivisions, and in this treatise the material part is mainly intended for illustration. The actual condition of our fellow beings, who occupy the various sections of the globe, gives a faithful panorama of all grades, from the most primitive to the most perfect state of civilisation, and in this picture the moral culture offers an equally vast and interesting field for contemplation, and which certainly presents more shadow than light. At some future day I hope to sketch out such existing facts as may serve as an outline for a more finished delineation of the "moral progress of mankind."

† This period (of such influential importance in creation) I proposed to be distinguished by the name of Post-Pleistocene, as synonymous with "post diluvial," or "alluvial."

the narrow path of civilisation. The actual life of some of our fellow-beings gives us a living panorama of what all over the globe, as far as we may reasonably conjecture, once was the condition of man in his primitive position. The truth of this we recognise in certain districts of the globe, as seen in the northern and southern extremities, where we find the Laplanders and the Esquimaux, the Patagonian and the Fuegian. From what we know of these tribes, the two first possess the use of fire, but some of the latter are still ignorant of the benefits of artificial heat, and consequently have to partake of food as nature offers it. Such human beings occupy, therefore, the lowest grade. These are not numerous, and are rapidly dwindling away; a circumstance apparently natural, considering the localities they occupy. There are other parts of the globe which offer similar views of a low and stationary life, in which certain aboriginal families still remain; while others, again, at no great distance from the former, are found more advanced in civilisation. This fact we observe in the original occupiers of Australia and New Zealand, both of which are familiar with the use of fire, though the former have remained without any further improvements, being considerably below the latter in social condition. Directing our attention to the aboriginals of South America, who had reached the highest degree of civilisation among the tribes occupying that part of our globe, and considering the state of intellectual culture of the Mexicans and Peruvians—next to these, observing the Indian tribes of the interior of that country, or the regions of the Andes; thence passing to the southern parts of the continent, where a certain portion of the Patagonians and Fuegians still exist in their original state—the contrast is so great that we may wonder at the causes which led to such marked difference in the material improvements of these our fellow-creatures, though inhabiting adjoining portions of the same continent.

Assuming that the human family, all over the world, has apparently had to struggle from the same state of ignorance, slowly to discover how to commence and how to continue the path towards material and mental improvement, it certainly is worthy of attention to ascertain, from existing facts, what has caused the advance of some and the stagnation of others; or what have been the means by which *man* in the wilderness was enabled to commence the important task of material and intellectual culture; and further, what were *the means* required to support and realise a greater perfection of civilisation? Here the subject for observation is the material improvement, the development and perfection of our nobler intellectual faculties, in a higher degree of civilisation, being the result of the moral culture.

This question is of importance for our own history, and may, perhaps, not have been so minutely attended to as it deserves; I, therefore, now offer the result of my investigations, with the intention of presenting a view of the ways and means by which the material

improvement of our species became stimulated and developed—how it originated and how it advanced. I, therefore, wish to direct your attention to *man* in the wilderness, *man* left to his own capacity, though, be it well understood, always under the protection and guidance of *Divine Providence*.

Self-preservation being the first law of nature, the first object of man in his primitive state must have been, as it still is found to be, the support of life. The means for killing animals in the forest attracted an early attention; in the fragmentary rock he found the first implement for this purpose. In this action we see the first proof of the superiority of man over the irrational beings by which he was surrounded. Man soon found his superior position, and the mastery he owned over the bear and the wolf, which, while giving him food, also provided him with clothing, the first necessities of nature being thus provided for.

Archæological researches in different parts of the world give an interesting idea of the means by which the human intellect commenced its culture at the dawn of civilisation. The northern countries of Europe, as Finland, Sweden, Norway, and Denmark, made very slow advance, owing to the severity of the climate. In progress of time the fragmentary rock of a larger size was used as the means of distinguishing burial places, as may be seen in those northern countries. These large blocks signalled the tombs of distinguished men, as chiefs and warriors. Considering the large dimensions and the great weight of such tombstones, which had to be transported for long distances, further to become arranged in the manner in which they are actually found, we have reason to admire the ingenuity displayed. These communities have, further, left testimonials of their higher intellectual culture in the early days of their social life, represented in their traditional records, or their writings, known as the "Saga," transmitted by the "Rune Skrift," or hieroglyphics on stone, found in flat granite blocks, purposely prepared; these may be seen in the localities where meetings, "tings," were held, marked out by granite blocks placed in a circular or oval form; these are also occasionally found at some depth below the surface.* From these evidences we infer that certain records, worthy of remembrance, occurred at a period when stone and wood were the only substances known.

The human family began its civilisation under equal circumstances, though more or less favored by climatic influence. Very few are the communities which, from so early a period of civilisation, have kept testimonials transmitting their thoughts by signs or writings. These facts demonstrate superiority in that branch of the great family which was destined gradually to assume the supremacy

* The Peruvian *Quichuas*, under the Incas, used symbolic signs, known as *quipos*, in knotted cords of variegated colours.

over its fellows, the Caucasian taking the sway over the rest of the other human races of our globe.

The hidden stores of nature, concealing most valuable materials for the improvement of aboriginal life, remained unknown to the inquisitive eye and mind all over the globe for a greater period of time than we might imagine ; and it is interesting to consider how this continued ignorance still exists in many parts of the world !

The discovery of a substance so unique and so influential as that necessary to excite attention and give occupation to the mind, opened therefore, a new stage in the material prosperity of man. Certain metals, with their peculiar qualities, are next observed to have produced most beneficial results, as furnishing quite new means for occupying and gratifying the mind, and also for cultivating the inventive faculties. In different parts of the globe the metals that first came under notice were dissimilar. Where gold prevailed, it became the first ; and where copper existed among the fluvial detritus, it took precedence, both of these metals being found in a native or metallic state. But these two metals, even where first found and brought into use, though they served as influential means for cultivating the intellect, their material benefit was still very limited. A new metallic substance was required to produce a material of more extended effect. The discovery of *tin* presents us with this new and important agency, by which a most beneficial result was attained ; large communities being elevated by it from a semi-improved state of civilisation into great and wealthy nations.

That a Providential protection and foresight existed, and exists, we continually find when we become initiated into the means by which the human family has been aided to work its way through the thick wilderness into the cultivated field of society.

We see how *gold* and *copper*, found in a metallic state, are often superficially distributed in nature ; and being of easy access, they were destined as the means for introducing an idea of metals in general. The *tin* was not offered in a metallic state, but was like the other two metals found among the fluvial deposits where gold and copper had been obtained. The dark colour and the great weight of the pebbles and small gravelly fragments, known as "stream-tin," no doubt attracted attention. Such a pebble, when for curiosity sake, broken, would in its fracture of metallic lustre lead to the idea of its being examined, as gold and copper at this time were known to be capable of being reduced into a liquid state by heat. Tin having thus come under notice, induced the formation of an alloy with it and gold, and also of copper, when it was found that a small portion of tin melted with copper produced a very hard compound ; and *bronze* was the result. The discovery of bronze, in giving a substitute for the as yet undiscovered metal iron, where it became known, produced most beneficial effects ; a high degree of civilisation was achieved by those who became acquainted with the

alloy. Examples of this are supplied by the Asiatic communities, and others occupying the southern portion of Europe. The South American tribes, which were favored with the use of tin and copper, also reached a higher stage in social improvement than others which were ignorant of the existence of tin. Certainly, the tribes of Mexico and Peru had as much reason as other communities to admire the discovery and result of bronze, the greatest and most important that ever was made in that section of the world discovered by Columbus. This new discovery became not merely of material interest among the Aztecs and Peruvians, but it also was the means of a moral influence, because this new metallic compound served the Peruvian ruler, in the eyes of the multitude which he governed, by making it appear as if placed in direct communication with the sun, the object adored by the aboriginals and their Inca as their god. Human skill having invented the reflecting mirror, made the rays of the early morning sun ignite the combustibles on the altar, whereupon sacrifices were offered in adoration of their heavenly lord, from whom so many and such essential benefits were received. From this eventful discovery, who, among the astonished people dared to question or deny the Inca and his family being the offspring of their heavenly protector?

Like all other nations acquainted with the use of bronze, the Mexicans and Peruvians partook of improvements in the materials more immediately wanted for domestic purposes. Implements for cutting and splitting wood* for agricultural use, the plough-share and the hoe, become known; these latter previously had been made of the alloy of copper and gold. Though far below that of the Greeks and the Romans, the advance in social development reached by the Aztecs and the Empire of the Inca, no doubt originated from the discovery of copper and tin.

About the time tin became known, silver was discovered in Peru and Mexico; and there is reason for supposing that the latter was the first known, because native silver was found at the surface of the silver deposits of Potosi, and other silver mines, which at that time produced those argentiferous minerals, when under such circumstances there was inducement for attention being given to the pebbles of per-oxide of tin, the "stream-tin," of a dark shining appearance and glittering fracture.

The art of casting having been introduced from an earlier period, at the discoveries of gold and copper, improvements had taken place; so that at the discovery of silver considerable perfection was displayed in the castings made in Mexico and Peru, where silver was extensively used. The records of the conquest of the American empires inform us "that Montezuma and Atahualpa were served in cups and plates of silver and gold, and that silver was used for cer-

* The saw was not used by the Romans; the use of this implement was also unknown to the Peruvians and Mexicans.

tain culinary utensils for the imperial household." The Mexicans and Peruvians had also attained a considerable dexterity in imitating various objects from the flora and fauna of their respective countries.* Numerous tribes of South America, not at all known to the Mexicans and Peruvians, though they had discovered gold and copper, had never any idea of tin, and consequently they were deprived of the improvements arising from the use of bronze.

In the northern countries of Europe, both copper and gold were introduced about the same period; and bronze was, through the discovery of tin, subsequently known.

Iron was, all over the world, the last discovered of the metals, being the most important, from its influence on the higher degree in civilisation we now admire. Meteoric-iron, the compound of iron and nickel, is supposed to have been abundantly found in certain districts of the globe, and in those early days having attracted attention, was the first iron employed. This supposition is supported by former discoveries, and that lately made of a large mass of the said alloy.† In other parts we have reason to believe that the hydrous oxide of iron, known by the more common name of "bog-iron ore," being derived from the most superficial and abundant sources, yielded an early supply of this metal. In the first period of the discovery of iron, when it became known how to convert the crystallised metal into the state of fibres, *i. e.*, cast iron transformed into malleable iron, we perceive that this was performed in very small quantities. A small piece of such wrought iron, as the blade of a knife, or that of a small saw, was looked upon as one of the wonders of the day, such a curiosity being fitted into a grooved handle made of gold or copper, owing to the greater abundance and ductility of those metals. These interesting records, from the period of the first knowledge of iron within the boundaries of Europe, are to be seen in several of its archaeological collections, of which that at Copenhagen is remarkable for its valuable store of facts and illustrations connected with the early civilisation of man.

From these general views of our civilisation, and of how the intellectual culture became introduced and gradually developed, it is evident that this grand object has been specially promoted by the discovery of the metals. That in some parts of the globe, where these means have not come under notice, we find that the material improvements have not advanced beyond a limited area; the amount being modified by the influence of local conditions, and particularly by the site,

* These interesting facts, like so many important fragments of information about these countries, have been well depicted by "the master-pen of Prescott," whose early death is so much to be regretted.

† A large mass of meteoric-iron is stated to have been found in the interior of Buenos Ayres, in the Argentine Republic, within the latter part of last year.

whether on the coast of the sea or in the interior of the land, but especially dependent on the zone within which the locality existed. The higher or moral cultivation was thus, by a Providential design, prepared for its perfection through these material instruments. In becoming better acquainted with the circumstances under which all this was promoted, it appears that there existed some substance that must have acted as the original promoter, forming, as it were, the basis of the benefits arising from ulterior discoveries made for the development of civilisation. The truth hereof we have to search for, as already mentioned, "among the first leaves of the often mysterious Stone Book." To accomplish this I propose that we should inquire into the incidents connected with the early life of the aboriginal occupiers of some portion of our globe, as we may be persuaded that, under Providence as the Ruler, even the most obscure corner of the world will reveal what may be termed the fundamental mysteries of civilisation. I therefore ask you kindly to follow, and by your faculties to penetrate with me into the interior of some desolate tract of the Andean region, there to watch some of the early days of the aboriginal inhabitant, with the object of tracing out what in reality may have happened, by experience, to that son of nature "twenty centuries ago."*

Man in the wilderness—man in his natural position, and so as we have reason to imagine him in the earliest stage of life—the life of an aboriginal family, is what we here are going to contemplate. It was after the sun had passed the meridian, when we find the robust hunter, eagerly following the rapid movements of one of the larger quadrupeds of the forest, which (avoiding its persecutor on the slope of the cordillera at the precipitous border of a mountain stream) made its sudden escape, passing the boisterous torrent. The hunter had been defeated; he had failed to stun or kill the "danta" (the *tapyrus americanus*) which on several occasions had provided him with food; he was tired, and he went to quench his thirst; he sat down on the border of the rivulet, contemplating the escape of the two swift danta. He had a wife and children, and that day had been one of disappointment. He went a second time to refresh himself with the crystalline waters, when his eyes met an object not far from the cascade, among the sands of the rivulet. Without care beyond anything that would mitigate hunger, he notwithstanding soon found himself close to the strange object, which he contemplated, and being persuaded that it was not at all like what he generally met with on the borders of brooks and rivers—he found it, therefore, to be a strange object lying among the dark-colored sand on the border of the streamlet. He stood there at the foot of the fall, observing these small, flat, smooth and bright particles, to which the evening sun

* See Prescott's "Conquests of Mexico and Peru," regarding the supposed period of populating South America.

gave a still more dazzling lustre ; the color resembled the flower of a tree, which his wife had gathered for their young ones, the color being of a light yellow. He stooped down, and gathered a few of the glittering particles, being about the size of his smallest nail. In a moment he thought, "let me try it," and placing the larger particle between his teeth, to his surprise, he left the impression on the smooth surface—"Surely this was not like sand and gravel. But," added his passing thought, "this cannot appease hunger ;" and he made a movement for throwing this trifle back into the noisy waters, when he remembered his little ones, and folding the new substance in a leaf, he placed it in his bag of monkey-skin, used for carrying a provision of stones, the only missiles known for procuring food from the bush. His wife had been more successful that day ; she had killed a great lizard. On the arrival of the husband, they, with the children, partook of the reward of the troubles of the day. After the meal, the father placed the leaf with the yellow particles in his wife's hands, who gave them to the children. These yellow, shiny little objects may be supposed to be *the first particles of gold discovered*.

Time passed on, and as the first discovery led to the finding of some more of the singular matter, it was gathered, and though of no apparent use, yet, all the members of the family liked to look at the "soft yellow sand," which served as a toy for the children.

The rainy season had set in, heavy thunderstorms were frequent. A kind of shelter had been made of branches from fallen trees and some large leaves ; hides of several animals serving the purpose of sheltering, and also that of protecting the youngest of the family. One morning before daybreak, after a continued thunderstorm, which had prevailed during the night, the couple were awakened by a noxious smell, and on the day becoming lighter, a thick vapour now and then enveloped the shelter. All rose to avoid the suffocating fog ; on advancing towards the place wherefrom the unknown visitor seemed to appear, a sight was perceived, which, seen for the first time, must have produced feelings of astonishment. Lightning had struck and set fire to a large tree, which, with very little flame, produced dense smoke, by the natives viewed as a most disagreeable cloud, until this moment having had no idea whatever of fire and its effect on combustible matter. The surprised observers were acquainted with the lightning ; but until then they knew not its power of igniting, and the consequences of the phenomenon was to them unprecedented. This most singular incident occupied their thoughts for a long while, which led to contemplations on "the benefit which might be derived from the unexpected artificial heat." Until then the sun had been the only known source of heat, though to a small degree compared with what they now had before them. The family were the whole day occupied in gathering branches and half-decayed trees to support the fire. Fire was also applied to many lofty trees, with the view of subduing them. Thus, this new-born flame, given

from above, was secured, and from this happy day in the history of man, the lizard was roasted and the manioc-root was baked. Certainly, the day when the igneous element became known to the sons of the wilderness, was one of the most eventful in the history of the wide-spread children of Adam !

The root of the manioc, the *jatropha manihot*, grows in all hot and temperate parts within the tropics of South America, being of a conical shape and often of large size, several feet in length and several inches in diameter. This natural production of superior bread-food was viewed as a providential aid. It is, therefore, much sought after and used by the aboriginal dwellers of the Andes.* By the means of fire a wooden implement had been produced, and by this access to the larger manioc-root had been much facilitated. One day, on the lower portion of the mountain slope, the extraction of a large manioc occupied the aboriginal family ; the vegetable soil had been worked through, next to which a deep layer of sandy earth had to be dug out, the much coveted manioc still penetrated, and so the excavation had to be continued. The growth passed now through an entirely strange soil, of a color resembling the sky on a clear summer day ; it was not at all like the black soil frequently met with, because it was tough to dig, and it was pliable. The manioc being extracted, was, with some of the curious earth, brought home. A substance, somewhat similar to the new earth had been known for some time ; this was the wild bees' wax. Of this some playthings had been made for the young ones, and now the mother shaped a few little objects out of the new matter. As a good fire was kept up, some of these little trinkets were placed near the hot ashes, because it had been observed that they had become harder in the sun, thus not being at all like the beeswax, the honey of which, by the way, provided the only sweet substance known at that time. On the following morning a new and unexpected curiosity was met with. Whoever would have imagined that some of the basin-like playthings (imitating, it may be, the shells of some fruits) having fallen into the fire, were now found entirely different and changed in their appearance, when compared with those that had not been exposed to the strong heat ; the color was changed, they had become totally altered from a soft earth to a hard substance !—How pleased was now the mother with her discovery, and the idea of taking some water, to try the new vessel, soon presented itself to the mind. One of these little cups, being left with some water close to the fire, after a short while the water began to boil. Great must have been the astonishment with which these two phenomena were observed for the first time ; and still greater would it have been had the discoverer then comprehended the vastness of the discovery !—Singular it

* The manioc, or "*yuca*," so termed by the Spaniards, is extensively cultivated throughout South America.

is to find, that the first of these influential discoveries has, even until this moment, never been contemplated to the extent of its importance. Certainly, the rudiments of the greatest and most influential discovery ever made had then been accomplished ; one with which the faith of the human race has been so intimately associated ; and what was this, producing only a few playthings, at that time thought of as much as were the first grains of gold, which also occupied a place among toys of no value ? What might this mysterious substance be, is the question which now presents itself ? I here beg to repeat, "that among the first leaves of the often mysterious Stone Book we find the secret revealed." The material development of the hidden seed of intelligence had to precede that of a more sublime culture in moral and divine objects. This mysterious crude substance had, like many other providential agencies of an unknown nature, become introduced to man nearly all over the world, though at very different periods, as we are aware that the population of distant tracts were not all made acquainted with the same fact at the same time ; and though by historical records we know the effects of this discovery for some thousands of years, yet it is only of late that the light of science has introduced its rays over some departments of the vast laboratory of nature, thus giving a true idea of this most influential among the known simple means. But, as just stated, the beneficial effects of the substance now under contemplation being achieved, have worked wonders throughout the gradually civilising populations ; but as far as I have been able to observe, no notice has ever been taken of the importance of this substance among the original elements promoting civilisation. What we know of the bodies termed *elementary*, and which altogether constitute, as ingredients, that great combination of chemical compounds we see in the mass of our globe, surrounded by the atmosphere, and animated by the magnetic and the electric fluids, we owe to the genius of those who have devoted their time and labor to the study of the secrets of nature which surround us. The benefit derived from our chemical knowledge is *reality*, and is, therefore, of immediate usefulness for the higher stages of civilisation ; it is, consequently, one of the most sublime and useful of sciences, and to it the world is indebted for many of the improvements which have enriched the stores of material welfare. Among the most interesting and important elementary compounds, we now beg to name that of the *ter-silicate of alumina*, commonly known by the name of *clay*. *Clay* will, through all generations, be viewed as the origin of our first step in the narrow path of civilisation.* Vast is the importance of this substance, when we consider

* In the superficial structure of our globe we have to admire the great importance and powerful influence that *clay* exercises by its geological position ; one of the many results we find in the benefit derived from artesian wells.

it as the means by which all our metals have been reduced into a fluid state, and separated from their ores. Further considering that without *clay* no metals would have been produced, and that for want of metals we should have remained in a stationary position as regards our civilisation, that is, in other words, we should have occupied a position and order of tribes similar to that of the New Zealanders, as they were found at the discovery of their islands, nothing better; because, though the New Zealanders have employed the clay for repairing their canoes, they never thought of any farther use of this substance, nor did they turn their attention, like many other tribes now existing, to any kind of metal.* The question may here follow, cannot clay be substituted by some other substance? If so, the aboriginal occupier has not known it, and if science has not discovered and does not find a substitute, that will just answer the question. Nature has not as yet offered any substitute for clay, therefore it occupies the highest position among the known compound substances, being, of all, the most essential for reducing or liquifying the metals, which, in their turn, became powerfully available as indispensable for the development of civilisation.

Inquiring into the benefit obtained by the discovery of clay among the Indian tribes of the Andes, we find by the discovery of earthenware, found in the tombs of the said tribes, the following facts, viz., that after attention had been paid to the search for gold and copper, a vessel for concentrating the metalliferous sands was contrived by the goldseeker of those early days. This consisted of a circular dish, somewhat similar to a watch-glass, in which, by a rotatory motion, the heavier particles, as the gold and the black-sand, were kept together in the centre of the dish, whilst the lighter sand was washed off, sufficient water being kept in constant use for the purpose of separating the lighter and retaining the heavier ingredients. This simple contrivance gives an idea of the inventive skill of the first gold-washers of South America, who, without the means of clay, could not have reached the perfection they did in collecting gold and copper,† so satisfactorily proved by the records of the Spanish conquerors, and also by the variety of gold trinkets found in the burial-places. Next to this useful washing-dish, which by the Spaniards was improved by making the same of wood, being still in use all over South America, a circular and conical-shaped piece of clay was used for the heavy part of a spinning-bob, through the hole of which a straight piece of wood completed the first implement for making a thread out of the raw cotton. The said piece of burnt clay is fre-

* The superiority of the New Zealanders among semi-civilised people, is recognised by all who know their natural facility for inventing certain domestic implements, and prosecuting crude manufactures, &c.

† The Indian washing-dish is recognised as the best of all known implements for concentrating metals and metallic compounds, whether made of wood or gutta percha; the latter introduced by the writer.

quently found in Indian tombs, and is now actually in use among the civilised Indians of South America. Having discovered that gold and copper would become liquified by the aid of heat, smelting pots, or crucibles, were made from clay, as the only substance suitable for this important purpose, just as we find this substance employed at present.

The several imitations of animals and many other fancy trinkets for ornaments and embellishments, which had been shaped out of the wild bees' wax, became now the patterns for reproducing the same in gold, or an alloy of gold and copper. For this object, clay offered itself as the only substance in which the mould could be produced, and having embedded the wax model in clay, and drying the mould gradually so as to prepare it for a stronger heat, the wax model, in melting, left the pattern for the liquified gold. Without clay such castings could not have been produced !

Natural fluxes, for facilitating the liquifaction of the metals, were found in the nitrates of potash and soda, abundantly provided in Chili, Peru, and other parts of South America ; but where these were not available, the ashes of ferns were, by the aboriginals, used as a substitute.

Clay was further and most extensively employed for making different kinds of pitchers of varied shapes, some of which were very large, being everywhere used for preparing a fermented drink from Indian corn (maize) and honey, the only intoxicating liquid then known in that part of South America. Cooking utensils were prepared from clay, as also a great variety of fancy-shaped vessels, some of which represented the human form. These manufactures were at the conquest seen in general use, and have been found in all the tombs. These burial-pits, or perpendicular excavations, have in some districts retained their original name, but the Spaniards distinguish with the term "huaca" those which contain gold and gold trinkets.*

The method in which the women and the grown children prepared the clay for making earthenware was the same as that we find the aboriginal tribes using at the present moment. The clay in a moist state is ground on a large flat stone by a smaller one. In many localities these implements are dug out from the sites termed "lavaderos de Indio," where the aboriginal workshops existed, and where gold and copper were melted and castings made, such as are found in the tombs, and also got among the leavings of gold and gold and copper in alloy.† These sites in former days,

* In one of my later papers, presented to the Society, I have given a detailed description of these tombs and their golden contents.

† These lavaderos, "washing places," were discovered about four years ago on the Andes, between the 5° and 8° north latitude. Some of these have been found very rich in spoils of the early Indian goldsmiths, who seem to have been very careless about their materials, which are found scattered about. Gold in its natural state is also found here.

which were occupied with great numbers of Indian artisans making moulds, melting the metals, and producing the castings, are now covered with a deep vegetable soil, through which the roots of gigantic forest trees now penetrate deep into the substrata of decomposed rock, and on which, at that period, the early ingenuity of man had prepared furnaces and other means for producing such manufactures as for the most part served the purposes of luxury or embellishment. The timber being cut down and burnt, water is generally brought to the spot, when washing operations lay bare the rock, and at the same time the remainder of the gold is gathered, the implements, as those of gold and copper alloy being also collected. Here is now seen the blocks which were used for grinding the clay, consisting of granite and trachytic rocks, several feet in length, and from two to three feet wide, all these being found worn down by such treatment to thin slabs. The grinders are also found, being oval-shaped stones or granite, such as they were prepared by nature, found in the fluvial depositions of mountain streams. "La piedra de moler," the grinding-stone, and "la mano," the grinder, were also most necessary implements for grinding the Indian corn, which was extensively used by the South American aboriginals; and still, in the present day, these two implements for preparing the clay and for grinding the maize, the staple bread-food, are used all over the South American continent.

Women and children at the present time occupy themselves principally in making the earthenware; and in the earlier periods when these useful articles were introduced among the aboriginal families, the same arrangement prevailed.

While, therefore, the women and the weaker members of the family were occupied in the new art, another branch of industry was attended to by the men, who gradually improved their weapons for procuring animal food. The simple spear, with some sharp stone, fixed to the point, was the first; but the bow and arrow were subsequently invented. The contrivance for sending missiles by means of a tube purposely made, was the last improvement made among the tribes of the Andes. This formidable weapon, with a poisoned dart, is still in use among the Indians, termed "bodoquera."

The valuable qualities possessed by clay are well known all over the world. This matter in its plastic, or more or less ductile state, though in itself not ranging among elementary substances, encloses a metal possessing rare properties. To the question: is there in nature any other matter that may answer for the purposes of clay?—to this we have already hinted, if there exists one, it has not been discovered; at least among the known mineral and metallic earths we do not see a substance for making an ordinary vessel, as that of earthenware, or for preparing a brick. In this state of things, if clay (the ter-silicate of alumina) had been omitted from the stores of nature,

or even if this substance only existed at greater depths, as below other strata, among the depositions of the Pleistocene epoch of the tertiary era, there is every reason to believe that the aboriginal tribes would not have been able to discover that which did not lie within easy access. Even where clay occupies the surface or the first stratum, some aboriginal tribes are known never to have taken any notice of it. Our nearest example hereof we have in the aboriginals of Australia, who literally have, in many localities, walked and still walk on the clay! With the fact before us, we view in the Post-Pleistocene arrangements a providential circumstance of vital importance for the benefit of man, and in this, at first sight, trivial distribution of clay, we see the mysterious means by which one of the greatest objects in creation was promoted, viz., the cultivation of the human intellect!

During the last geological epoch, where water acted as the agent, clay became distributed, partly in a second or third stratum, as well as presenting the last of depositions. Such superficial layers are noticed all over the globe, where the floods acted on a favorably situated locality, and where the silicate of alumina remained. The substance clay, thus, as we see, gave the last touch to and crowned the grand marvellous work of creation!

Having observed the great importance of clay as an original means of civilisation throughout the world, a glance at this substance, as known to modern science, will now briefly occupy our attention. Clay in its purer state, from pipe-clay to terra-cotta and kaolin, encloses an elementary substance combined with oxygen, forming the *oxide of aluminium*, this again being chemically combined with *silicic acid*. At the beginning of this century, Oersted had the honor of being the first who obtained this metal, and presented it to the chemical world as the *chloride of aluminium*. Wöhler, availing himself of the properties of this chloride, succeeded in procuring the metal in its metallic state, though in small quantities, as a mere scientific curiosity. Still this was a great step towards a perfection that might be expected. Such was lately arrived at by improvements in the mode of producing this metal in quantities. Science and the world at large are indebted to M. St. Clair Deville, who has lately simplified the process and means for producing it at a moderate expense.

Though aluminium exists wherever clay is present, this substance has, until lately, offered more difficulties in its extraction than most other compounds containing it. An unexpected source was discovered about three years ago, where a substitute for chloride of aluminium was found to exist. Dr. Percy found this in the *cryolite*, or fluoride of aluminium and of sodium, which exists in large masses in Greenland. This is the most appropriate ore from which to extract aluminium. Notwithstanding this natural aid for obtaining this

metal, its production must be viewed as one of the high results of science. Another compound of alumina, the sky-blue "lapis-lazuli," presents another and still more difficult accomplishment in chemistry, giving us a most splendid proof of the power of imitating a natural production!

In the physical properties of the metal produced from clay, we are gratified to find that the most extraordinary qualities present themselves. Aluminium is ductile and malleable, so as to merit comparison with gold. It is also an excellent conductor of heat and electricity, and is the lightest among malleable metals, its specific gravity varying from 2.25 to 2.60. Its specific heat is considerable. It is sonorous. Its strength, in reference to tenacity, has been compared with that of iron. The chemical properties of this metal are also remarkable. Though great difficulty exists in detaching aluminium from oxygen when combined, and though it might be reasonable to suppose that, in its metallic state, on coming in contact with the air, and so with oxygen, that it would attract that element with great readiness, still this is not the case. Aluminium is not acted upon by any acids at ordinary temperature, except the hydrochloric. Sulphuric acid does not attack it.

As for the usefulness of aluminium, many and varied are the purposes for which it will be adopted in the future. Suffice it here to mention, that being not at all liable to rust or oxidise, a thin coating of this metal on iron, the clean surface of which readily receives an adhering plating, will result in many and important extensive improvements in the arts.

Considering the lightness of this metal, when compared with silver, to which it stands as only one-fourth of its weight, a commercial benefit may be obtained, even at present. Dr. Percy observes "that aluminium unites with most of the metals, and according to M. Debray, ten parts of this metal with ninety of iron produce a compound having a greater hardness than bronze, and at the same time, when heated, possesses greater malleability than the best iron."*

In here repeating the *questio vexata*, "is it a physical probability that an aerial navigation may, in some future day, be arrived at, and an aerial vessel steered through the atmosphere?" we discern how this metal from clay may perhaps become the means for accomplishing the greatest enterprise ever attempted by the indefatigable intelligence of *man*—by man in a higher state of culture.

* The chemical productions of aluminium are very interesting and important; but space does not permit me here to refer to them, or to the many improvements social life will, at some future day, obtain from this most extensively useful substance, whether viewed as the metal aluminium or admired in the beauty of the ruby and sapphire, or the utility of the crucible, or the many applications of chinaware.

Thus we perceive how *the first promoter of civilisation* in the past, offers its aid for the future, and so has been and will be of the greatest influence, even presenting the means for traversing the light element by which we are surrounded.

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EXPLANATION

Of the allegoric figure of the aboriginal discoverer of clay in the regions of the Andes.

[To be presented by the Author to the Royal Society.]

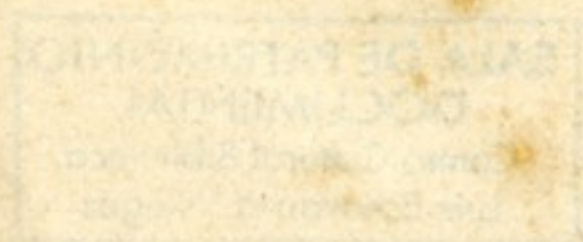
The discoverer, placed on the metal aluminum (the base of ter-silicate of alumina), is in the attitude of contemplating the clay held in his right hand; in his left hand is seen a branch or stake, the implement used on the occasion of finding the clay. Gold being the first native metal discovered, is seen next to the aluminum. Copper then follows, and next to this, an alloy of copper and gold. Tin, produced from the oxide of the metal, follows; and below this, the alloy of tin and copper, viz., *bronze*. Crystallized or *cast iron*, placed on *malleable iron*, resting on *steel*, concludes the pedestal. The figure is made of silver; the engraving shows about half the size of the whole. Here therefore is represented the discoverer of clay, having under his feet the substances, then unknown, but destined to become the means for future material civilisation.

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