

Preface

Humans have used clay throughout time. As a rule this material is always found close to water, and it can reciprocally indicate the nearby presence of water. In fact, in the history of our planet, clay has largely preceded humans who have taken advantage of its numerous and useful properties. If we consider that life has appeared and progressively developed in wet areas, while clay was being formed through destructive water action, it is fair to assume that over the planet's history a privileged relationship developed between living organisms and the very singular clay environment. This relationship supports the affinity of numerous animals for clays, including humans. Humans have progressively integrated clay in their culture and worship.

Clay, a popular material worldwide, has remained up to recent times scientifically poorly understood because it is constituted of minute particles (their very small particle size assigns clays into the field of colloidal particle properties; clay can be found as slurry, paste, and mineral dust, that is, in states that have long been unfriendly to the allocation of specific traits). Following the first scientific studies it has become pretty clear that clay is constituted of elementary particles whose dimensions, as a rule, are less than $2\text{ }\mu\text{m}$ ($2\text{ }\mu\text{m}=2\times 10^{-3}\text{ mm}$). This size criterion is actually a frequently mentioned fundamental factor although it is not exclusive to clay inasmuch as other minerals can display similar sizes. Contrary to most common minerals, clay particles rarely display regular shapes visible to the naked eye, nor do they show a permanent solid state. Despite these peculiarities, a priori unfavorable to its applications, clay can easily be recognized and its use generalized, whereas the properties of numerous other minerals that could be easily manipulated were only recognized much later. Two recently published books on this point present an excellent synthesis of the general medical applications of minerals: *Minerals and Human Health: Benefits and Risks/Os Minerais e a Saúde Humana: Benefícios e Riscos* by C. Gomes and J. B. Silva (2006), bilingual edition of the authors, Multiponto, Porto; and *Mineralogia Aplicada: Salud y Medio Ambiente* by M. I. Carretero and M. Pozo (2007), Thomson (Editor), Madrid. Two recently published articles deserve to be studied as well: “Clay Minerals and Their Beneficial Effects Upon Human Health: A Review” by M. I. Carretero (2002), *Applied Clay Science*,

21(3–4):155–163; and “Minerals and Clay Minerals in Medical Geology” by C. Gomes and J. Silva (2007), *Applied Clay Science*, 36:4–21.

The existence of clay in geological sedimentary areas provides this material with a particular role relative to water; clay is constituted of hydrous phyllosilicate minerals that are mostly derived from the weathering action of water on geological materials occurring at or near the Earth’s surface. Therefore, there are distinctive species of “clay minerals” in nature. Thus in this book we use either the singular to designate any individual or species within the overall existing clay minerals, or the plural to mean either a certain group of clay minerals or the clay minerals in general.

The origin of clays is essentially related to the degradation of diverse pre-existing rocks. Clays keep visible traces of their origin inside their crystalline structure and the physicochemistry in their particles: their size is always small, and their chemical composition and the atomic organization are always determined by the parent material. Clays are unstable and sensitive to any new environment where they coexist, although this does not grant them a definitive stable state. They react to very weak changes of energy and constitute a privileged intermediate state with an infinite number of natural reactions. Thanks to the extraordinary progress of scientific methods, the studies being carried out show the existence in these minerals of numerous defects (mainly formed by substitution of atoms and limitations of particle growth) relative to the ideal or theoretical model. Their physical and chemical properties and specificities are evidence of the initial heritage acquired in their original environment or of later adaptations connected to the eventual evolution of this environment over the course of time.

Clays are the essential components of the “original soup” frequently cited in scientific papers, from which every living organism has been formed. If clays have not truly been at the origin of life, we can assume that they have constantly been close to and accompanied it. They have contributed to make life possible and been effective performers and efficient partners. Civilizations and their religions have not been misled; all of them make spontaneous references to clay and to water, with which clay is always closely related.

Now, we can consider clays as a family of minerals which are very sensitive to environmental conditions. They can be considered as “structures in constant evolution”. Consequently, the fundamental research on clays is particularly dynamic and the prospects for their applications offer an infinite variety. Their specificities are very favourable to applications in the health field, where health and tradition finally could cross. In order to describe clays we should remember two important definitions:

1. The first is granulometric: They consist of particles whose sizes are, as a rule, less than 2 μm .
2. The second is mineralogical: They are hydrous phyllosilicates.¹

In the domain or field of human health (and of animal and plant health as well), the subject we deal with in this book, we should ask ourselves about the interaction between clays and the numerous living organisms of all types. Knowledge of the interaction mechanisms between living organisms and clays remained empirical

¹ Phylitic formed by a morpheme phullon, from the Greek *φύλλον* which means “layer shaped”.

until the beginning of the twentieth century; before then no solid scientific study was available or even possible. Physicians have progressively acquired and transmitted some very important practical information, although limited by the lack of an effective analytical methodology. Chemistry and physics have progressively provided the essential quantitative measurements confirming the crystalline mineral structure of clays, that is, the organization of atoms in a regular network. Since then, research has progressed rapidly, first in the industrial field, and lately in the less easily studied biological interface fields. Nevertheless, this scientific progress has not been accessible to everyone interested in the use of clays. Numerous interventions still remain totally empirical and undemonstrated or explained, a situation that could sometimes be dangerous. However, today there are sufficient scientific fundamentals to allow us to explain some positive effects of the use of clays in health. Sometimes the explanation is uncertain or even absent, but we have to admit the reality of the unanimously recognized positive effects, and postpone understanding them and their scientific explanation until later. The opinion of physicians evolves as shown in a recent book entitled *ABC de l'argile* by J. C. Charrié (2007), Grancher, Paris. Dr. Charrié is a general practitioner who tries, along with some colleagues, to find explanations of the traditional use of clay in scientific papers in order to justify its clinical use based on the integration of traditional information in science.

For the present it is important to express one reality firmly: with regard to living organisms, in general, clays are not healing or "curative," and we should not only remember the benefits. Even if some clays has useful properties, in some precise cases they can be hazardous too, such as chrysotile (a phyllosilicate that is part of the composition of asbestos, a technically very useful industrial mineral whose carcinogenic action on the pleura of the lungs is related to the fibrous shape of its particles). The term "asbestos" means a finished industrial and commercial product consisting of different acicular minerals (in the form of very fine fibers). These minerals have a special fibrous morphology and are resistant to fire; they are often called asbestos by mineralogists. Chrysotile (or white asbestos) $[\text{Mg}_3 \text{Si}_2 \text{O}_5 (\text{OH})_4]$ is a frequently used mineral, and is also classified as a serpentine phyllosilicate. One uses also amosite (brown asbestos) $[(\text{Fe}, \text{Mg})_7 \text{Si}_8 \text{O}_{22} (\text{OH})_2]$ and crocidolite (blue asbestos) $[\text{Na}_2 \text{Fe}_5 \text{Si}_8 \text{O}_{22} (\text{OH})_2]$ which are not phyllosilicates; these minerals belong to the amphibole family.

There are several ways to present clay properties; we use two fundamentally distinctive methods based upon the concepts of order and disorder, two fundamental stable states of matter. Because clay particles have a microcrystalline character, researchers have rapidly directed their arguments by first taking advantage of the crystalline state characterized by order; and lately by attributing a more important role to the microparticle itself. They have tried to understand the properties of certain assemblages, comprising a large number of clay particles: it is the disorder aspect that has been taken into account. Clay is formed of microscopic crystallites therefore the mathematic modeling methods could be applied to these two physical states of order–disorder, but that does not mean either an easy undertaking or that the obtained results could be easily extended from the microscopic to the macroscopic scale.

Oddly enough, clays simultaneously respond to two criteria related to very distinctive dimensional domains. Order exists at the microscopic scale; apparent disorder is seen at the macroscopic scale. Therefore, the definition of the representation scale is fundamental, inasmuch as there is a border zone, one kind of dimensional fracture, enabling each side to show different properties, and thus it is very difficult to find one justifying connection between these two states. It is constantly important to present applications that can be expressed and explained in both domains, sometimes through specific properties of both domains. This duality of order–disorder leads to the distinction of two main types of mechanisms, which direct the therapeutic applications of clays.

The order and disorder represent the true reality of natural states fairly well: between both matter states adaptability allows considering intermediate unstable states, frequently reversible and unstable. Nature needs stabilizing elements in order to maintain its stability dynamically over time, and for its renewal it needs sufficiently flexible and adaptable systems. Clay minerals show these two qualities. Their well-organized atomic structure is able to resist attacks taking place over time, sometimes over millions or even billions of years. Nevertheless, their great affinity for water and the presence of inherited defects related to their genesis allow their response, and rapid adaptation to solicitations that would have no effect on other compounds. Therefore, most clay properties depend upon their particular physico-chemical properties, which favor reactions of assemblage, of absorption and adsorption, and of exchange. Their high absorption capacity allows the fixation of numerous substances (cations or molecules), some of them toxic, a fact that gives them therapeutic capacities, particularly in the gastrointestinal system. Most of these mechanisms only require weak energies, with a frequently reversible intermediate state, similar to a catalyst reused almost to the infinite. A fundamental point to understand the mechanisms of clay minerals' action is their ionic constitution and their association with the compensating exchange of ions, or to the mobile molecules frequently involved in the main exchange reactions required and utilized in therapeutics.

Whenever clays are in contact with biological material (possibly alive), they represent two worlds and two completely different types of existence that encounter each other. This results in a great diversity of properties and applications. In order to understand how clay works it is important to consider that clay is always ready to modify and evolve itself to adapt and find the best balance.

Organisms or living beings are sensitive and reactive, some of them conscious. Our aim should not neglect the sensorial and psychosensorial aspects of the contact between a conscious living body and clay; in addition, higher living beings such as humans have the possibility of adjusting their responses to a certain perception. The expression *sweet clay* acquires a real dimension here: “We react well if we are well.” A kind of symbiosis between clay and the body takes place. Associated with water, and at an appropriate temperature, clay possesses this complementary property of setting in motion the perception of well-being.

Numerous and diverse traditional uses of clays have been known for at least 10,000 years. All civilizations with access to clays and having applied them were deeply influenced. From the beginning of the twentieth century onwards we began

to have a better knowledge of the properties of these minerals at both the micro- and macroscopic scales. Within the domain of their therapeutic use we can say that the scientific advances will bring about useful developments through the linkage of one classic chemical or physicochemical associated (or not) with a complementary and efficient psychotherapeutic effect.

At a time when science and technology produce marvellous useful materials, clay still continues to have remarkable efficiency in spite of the longevity of its uses. Presently its applications range from civil engineering works up to the nanotechnologies. In fact it is at this small scale that one can find the key to health applications which are dealt with in this book.

We limit our ambitions to recognized facts having properties that can be identified and quantified. Of course, the absence of scientific knowledge has led certain authors to establish cause-and-effect relationships without any solid significance. However, this does not mean, *a priori*, that their observations are without justification: it is the attribution being put forward that deserves to be more precise. We have chosen four examples from the literature, but there are many others:

1. *“Radioactive” properties of clays:* Phyllosilicates by themselves do not have such properties. However, clays mainly have their origin on the alteration of silicate rocks and thus have to obey the rules of erosion and detritism. Consequently sometimes they can be mixed with uranium compounds derived from the same rocks, which possess radioactive properties. Because such compounds are finely divided in terms of particle size, they could be separated with difficulty from clays, in all cases not naturally. In this way clay commercial products are weakly radioactive (we emphasize that this property is rarely measured and indicated on the clay packages.)
2. *“Magnetic” properties:* Those currently cited are not identified in clays. In fact, they result from the presence of fine particles of magnetic metal compounds that are mixed with clays.
3. *“Antibiotic or antiseptic” properties:* Although clays are frequently cited as possessing them, they do not have these properties, but because of their sheet-based structures they can constitute impermeable barriers to water and air in particular; it is obvious that they can preserve the organism from contact with a polluted environment and keep oxygen from reaching the surface of an infected zone thus prohibiting the development of certain microorganisms. Another property allows them, by adsorption, to assess adsorption molecules that are really “antibiotic,” but are only associated with clay. The confusion in these cases is always the result of ignorance of the complex mechanisms involved, which should be analyzed case by case, without generalization.
4. *Clay color:* This is frequently a commercial argument that is considered to be important; it is not systematically linked up with known properties, and is never the exclusive cause.

It should be noted that when radioactivity in clay treatment was first spoken about, the word “radioactivity” did not have the meaning it has today and there has been a semantic shift. The same applies to the word “magnetism”.

The authors' goal is not to fight these forms of obscurantism, but to contribute to a better interpretation of reality in order to make better use of clays thanks to understanding the way they build up and the way they work. The difficulties come from the microscopic character of the implied mineral phases, knowing that scientific studies allow a progressive correct interpretation of their properties. In this evolution clinical observation cannot be disregarded; nowadays the latter is frequently forgotten, but through the impacts it has upon life, it allows the orientation of analytical research and opens a way to new scientific perspectives.

To sum up, the authors' goal is not turned towards a controversy aimed at what cannot be verified but is focused towards well-established scientific knowledge that is likely to evolve, and resolutely turned towards an enlarged use of these particular minerals. Their application in new methods of biomineralogy is presently being developed by research laboratories. Clays have almost always been characterized by the concept of balance. This notion of balance is also a harmonious factor in life: the quest for balance allows natural activities to occur and act so that all the vital functions of an organism participate in its life.

In the health field, the use of clay is too ancient to be completely supplanted by supposed modern scientific or medical pharmaceutical methods.

Clays are components of the mineral kingdom and humans have almost always been living in contact with them. Water was the main actor in the formation of clays during the Earth's geological formation process; water remains the main source allowing life to exist. Life appeared in contact with these two elements. Therefore the strong interaction between clays, water, and living organisms is not surprising. Among the living organisms human beings have the advantage of being able to arrive gradually at an understanding of the interaction mechanisms between clay and humans.

If scientific medicine did not exist, empirical medicine would be the only one at our disposal, as it has been for a long time. Under certain conditions, it is still being used and will probably continue to persevere. Mankind has the chance of possessing these two very different approaches of medicine that can be mutually enriching.

Long before being able to explain the various properties of clays and their interactions with health, humans very quickly recognized their utility. In the absence of scientifically structured thought, they initially transposed on a mystical level what they could observe. Legends and myths were thus born, often rather close to reality. Humans, conscious of their existence and their mortality, always felt the need to know their origin.

The progressive evolution from legend to a desire for knowledge occurred naturally, bringing with it a religious approach. Thus, almost all religions contain traces of this heritage. If we can clarify this approach today, we must recognize that the existence of these beliefs is little by little getting closer to our scientific model. This evolution does not remove anything from the spiritual interest but makes it possible to give it a status closer to reality. Thus, the legendary world enters into the unfolding of history.

"Man is made of clay." That is a vista opening a vast cultural, religious, or simply vital domain of reflections.

This development is found historically in the use of clay by humans. Today we can see a transition towards a scientific expression of these uses. For many people it is, however, quite difficult to forget this apparently magic aspect of clay, symbolically named “ground” or “earth.” We do not try to reverse this tendency but simply hope to offer all those who express the need or the wish an access road to the scientific methods. Let us not forget that anything which allows a real return to the balance and harmony of health cannot be neglected: at least the many properties of clays permit this choice.

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