

The “Table of mineral classification” by Oscar Nerval de Gouvêa: mineralogy and medicine in Brazil

A “Tabela de classificação mineral”, de Oscar Nerval de Gouvêa: mineralogia e medicina no Brasil

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Abstract

Oscar Nerval de Gouvêa was a scientist and teacher in Rio de Janeiro, Brazil, whose work spanned engineering, medicine, the social sciences, and law. This paper presents and discusses a manuscript entitled “Table of mineral classification,” which he appended to his dissertation *Da receptividade mórbida*, presented to the Faculty of Medicine in 1889. The foundations and features of the table provide a focus for understanding nineteenth-century mineralogy and its connections in Brazil at that time through this scientist. This text was Gouvêa’s contribution to the various mineral classification systems which have emerged from different parts of the world.

Keywords: Oscar Nerval de Gouvêa (1856-1915); mineralogy; classification; medicine.

Resumo

Oscar Nerval de Gouvêa foi um cientista e professor no Rio de Janeiro, Brasil, cuja obra abrange engenharia, medicina, ciências sociais e direito. Este artigo apresenta e discute o texto intitulado “Tabela de classificação mineral”, que ele anexou a sua tese *Da receptividade mórbida*, apresentada na Escola Superior de Medicina, em 1889. Os fundamentos e características da tabela propiciam a compreensão da mineralogia do século XIX e suas conexões no Brasil à época por intermédio desse cientista. O texto foi a contribuição de Gouvêa aos diversos sistemas de classificação de minerais originados de diferentes partes do mundo.

Palavras-chave: Oscar Nerval de Gouvêa (1856-1915); mineralogia; classificação; medicina.



The engineer and physician Oscar Nerval de Gouvêa (1856-1915) was a scientist and teacher whose career unfolded in Rio de Janeiro, Brazil. Although virtually unknown outside of Brazil (and still relatively unknown even in his homeland), he was quite prominent in his time, as demonstrated by a public school¹ and street² in greater Rio de Janeiro named after him. Gouvêa was born in the city on September 15, 1856 and died there on November 14, 1915. He studied engineering at the Polytechnic School, medicine at the Faculty of Medicine, and social sciences and law, all in Rio de Janeiro. What interests us most in this paper is the “Table of mineral classification” in manuscript form which he added to his dissertation, *Da receptividade mórbida (On morbid receptivity)*, which he presented on October 10, 1889 to graduate from the Faculty of Medicine. This article investigates the Table, which is as relatively unknown as its author. We briefly discuss its foundations and main features to obtain an understanding of mineralogy and its connections in Brazil at that time through the pivotal figure of Nerval de Gouvêa.

As pointed out by Matthew Eddy (2008, p.1) in his exploration of the classification system developed by the Rev. Dr. John Walker, a key figure of the Scottish Enlightenment, classification is an essential part of science. Martin Rudwick (1996, p.267-269), specifically addressing mineralogy, reminds that

minerals, no less than plants and animals, were to be described in terms of their natural ‘species.’ ... But most mineralogists ... were not content merely to identify and name their specimens. They wanted to construct a classification that would assemble similar minerals into a nesting set of groups, and so reveal the hierarchical structure of the diversity of the whole mineral kingdom (emphasis in the original).

Although some authors had focused on inorganic classification, of fossils as well as minerals (Guntau, 1984; Laudan, 1987; Hooykaas, 1994; Corsi, 1998), this topic has still received little attention in the history of geological sciences compared to Neptunism, Plutonism, Volcanism, Uniformitarianism, Catastrophism, or mapping. This may be because “the ‘revolutions’ historiographic model [markedly present in the history of geosciences] often concentrates on grand movements of scientific ideas, the day-to-day practices of naturalists and experimentally-minded physicians have not received adequate attention.” (Eddy, 2008, p.1). For this reason the methodological, experimental, or pedagogical contexts in which these ideas were forged remain overlooked, and many of the thinkers who produced them were edged into irrelevance; this is the case not only in eighteenth-century Scotland or Europe, but even more so in Latin America and Brazil.

Geology and medicine: two words that go together well

The link between geology and medicine has a long history: mineral-based medications were well-known and often employed from the earliest times, and medical professionals played a relevant role in the history of geological sciences. Old Iranian documents on traditional medicine mention the physicochemical properties of minerals and various methods of administration. Specifically, as noted by Darbandi and Taheri (2018, p.25), the use of sulfur, sulfide, and sulfate minerals was documented in Avicenna’s *Canon of*

medicine and Jorjani's *Zakhireh Kharazmshahi*. In the Modern age, Paracelsus (1493-1541) strongly advocated mineral prescriptions, alongside those of plant and animal origin (Edler, 2013). An approximate contemporary, the famous physician Georgius Agricola (Georg Bauer, 1494-1555), worked in the mining regions of Bohemia (Joachimsthal) and Saxony (Freiberg) and wrote *De re metallica* (1950), a landmark work on mining and geology as a result of his practice intertwining medicine and geology through the diseases that affected miners (Wilsdorf, 1970).

Long after works such as those by Hippocrates (*On airs, waters and places*), Pliny the Elder (*Naturalis historiae*), and Dioscorides (*Materia medica*), the tradition continued to the early twentieth century. These two fields of knowledge still shared various themes, such as mineral deficiency, therapeutic effects of mineral substances, and repercussions from volcanic dust and other geological products in human and animal health (Bergman, 2013, p.279). In the nineteenth century, diseases linked to trace element deficiency were identified, and public health textbooks explaining geological impacts on health were published (Bergman, 2013). Gouvêa touched on this phenomenon in his medical dissertation (as we shall see). Another Brazilian example of the links between medicine and geology is the mining engineer Antonio Ennes de Sousa (1848-1920), who graduated from the Bergakademie Freiberg in 1876 and also studied at the École Pratique des Hautes Études (Paris) and Zurich University (Blake, 1970). In 1880 he delivered two popular conferences on the relations between labor, health and subterranean life ("O mundo, o trabalho e a vida subterrânea") (Fonseca, 1995).

Until the nineteenth century, medicine and natural history were very close in academic and professional terms. In Scandinavia, Scotland, and the Netherlands, systematic classification was taught in botany, chemistry, and *materia medica* courses for medical degrees (Eddy, 2008, p.2). Several of the founders of the Geological Society of London were physicians, such as William Babington, who published a new system of mineralogy in 1799 (Duffin, 2013). In some American states such as Tennessee, early doctoral dissertations were relevant sources of information on the local geology (Corgan, 1985). Another scientist who was roughly contemporary with Gouvêa and who shared some similarities was the physician and pharmacist Hermann Georg Fühner (1871-1944), who addressed lapidaries and bibliographical references in his 1902 doctoral dissertation, proposing the utilization of "lithotherapie" (Duffin, 2013). Although original, this initiative remained isolated, as did Gouvêa's classification from the same time period.

Gouvêa's profile is analogous to many others who were older or his contemporaries, and is one of the three types described by Angetter, Hubmann, and Seidl (2013) in the Austrian case, namely scientists who completed some form of both medical and geological studies at university.

The author: a "hidden figure" named Oscar Nerval de Gouvêa

We were unable to find an image of Gouvêa. He is described as "short, rotund, bald, showing an intellectual organization of first order, which made physics and chemistry almost smiling due to lessons based on both knowledge and kindness" (Dória, 1997, p.164).³

Sacramento Blake (1970, p.342), in his monumental bibliographical dictionary, stated that Gouvêa possessed a “robust and cultivated intelligence, with excessive activity,” and was “one of the most enlightened Brazilians I know, and a useful citizen to his country.” One of his most remarkable students, and later his assistant at the Polytechnic School, Everardo Adolpho Backheuser (1879-1951), once expressed his admiration by saying, “With him I learned to discipline my philosophical reasoning; from him, I finally inherited the chair where he worked so brilliantly” (Musso, 1955, p.91).⁴

Nerval de Gouvêa devoted his life to education, his own but particularly that of young people. The subjects he taught ranged from mineralogy and geology to physics and chemistry. He was a professor of geology and mineralogy at the Polytechnic School in Rio de Janeiro, which he joined after presenting his dissertation on Brazilian plutonic rocks in 1880 (Figueirôa, 1997). He later served as the director of this institution, in 1911-1912.

Gouvêa taught physics and chemistry at the prestigious Pedro II School from December 27, 1884 (Brasil, 1885) and left a positive mark: the six best students in physics and chemistry each year received the Nerval de Gouveia prize, which was established in 1921 by a group of his former pupils (Soares, 2014, p.59). He also authored a textbook on physics entitled *Lições de física (Lessons in Physics)*, a compilation of his classes in accordance with the official syllabus (Gouvêa, 1902) that served as a model for dozens of schools around the country (Vechia, Lorenz, 1998). It was an updated book that emphasized both the description of technological devices and mathematics, although it was not excessively formal (Nicioli Jr., Mattos, 2008, p.213).

Among his other political and technical positions, Nerval de Gouvêa was a member of the City Council on Public Instruction during the Republic, actively supporting free schools. This is seen in the founding of two schools by Gouvêa and his colleagues: the first, the Free Normal School (Escola Normal Livre) was founded on May 18, 1893 and was equated to the official Normal School some months after its creation, receiving financial support from the government (Silva, 2015). Gouvêa acted as its director, assisted by Army Major Hemetério José dos Santos (1858-1939), an outstanding Afro-Brazilian grammarian, philologist, and writer who also taught with Gouvêa at the Pedro II School (Silva, 2015). The Free Normal School was tasked with preparing teachers for public, general, and even popular education, and accepted black and white female students (although the former group was smaller, as might be expected), as well as boys and girls in the primary school attached to the institution. The other school he founded, in 1898, was the Brazilian Gymnasium (Gymnasio Brasileiro), a secondary school for women’s education where he also taught physics and chemistry.

It should be noted that these educational establishments were launched at the beginning of the First Republic, when Positivism influenced political and intellectual. At that time various different and competing concepts of education were at play, all anchored in the assumption that instructing the people was critical to achieving “progress” and “civilization” fundamental pillars of the Republican government (Schueller, 2008; Torres, 2012; Lorenz, 2015). The first three volumes of Comte’s *Course on positive philosophy* discuss mathematics, astronomy, physics, chemistry, and biology, and latter volumes add sociology.

Besides Auguste Comte's Positivism, Herbert Spencer's Evolutionism (Weinstein, 2017) also had a strong influence on Brazil's intellectual climate from roughly the 1870s to the 1920s (Barros, 1986). Spencer believed that education helped develop natural abilities; in describing this context, Barros (p.45) states,

The phrase quoted so often by Silvio Romero – 'Comte was only cast out of love for Spencer, Darwin, Haeckel, Büchner, Vogt, Moleschott, Huxley' – is not just a personal case: it characterizes the evolution of the new Brazilian intelligence, which would keep the French philosopher's 'positive spirit' and, generally, the belief in the law of the three states. 'Positivism' becomes 'scientism'.

Although a more profound discussion on this aspect is not included in the scope of this paper, Gouvêa can undoubtedly be considered a Positivist as well as a Spencerian: Comte and Spencer were the first authors he listed in the bibliography of his medical dissertation. Furthermore, in my view his pervasive emphasis on the use of mathematics and quest for unity between the inorganic, organic, and social realms that are visible in his texts confirm this categorization. At that time, philosophy was considered to have to become "scientific;" in other words, it had to recognize the "unity of nature," a huge and unbroken chain of causes and effects (Barros, 1986, p.107). The three graduate courses Gouvêa participated in during his lifetime may also express this view: engineering (inorganic level), medicine (organic level), and law and social sciences (social level) combined to provide a broader, encompassing, personal understanding of the world. Gouvêa's somewhat speculative tendencies can be observed from the very beginning of his academic career. In 1879 he published the article "Função cosmogênica do éter" ("The cosmogenic function of ether") in the *Revista de Engenharia* (Siqueira, 2014).

In the field of medicine, Gouvêa's practice was in line with homeopathy (cf. the International Homoeopathic Medical Directory of 1898) and he attended patients privately, often for free. Homeopathy was first introduced in Brazil in 1840 by the Frenchman Benoît-Jules Mure (1809-1858). It initially was supported by Emperor Pedro II, but disputes between allopaths and homeopaths later arose (Luz, 2013). Eventually, the Hahnemannian Institute of Brazil (created in 1859) was officially recognized in 1880. In the latter decades of the nineteenth century, homeopathy was embraced by the supporters of the Brazilian Positivist movement at the Military Engineering Institute in Rio de Janeiro (Edler, 2006). The Republican government consequently provided significant official support for homeopathy at the beginning of the twentieth century, recognizing its teaching and practice and creating infirmaries at the Central Army Hospital and the Navy Hospital. Prominent Brazilians such as Monteiro Lobato and Rui Barbosa also sought homeopathic care. Homeopathy is rooted in a holistic view of the human being and relies extensively upon mineral-based medicines, Oscar Nerval de Gouvêa's domain.

It is also important to mention that Gouvêa was an Esperanto enthusiast, founding an Esperanto club (the Brazila Klubo Esperanto) on June 29, 1906 and serving as its second vice-president. Joining him in this endeavor were the president, Everardo Backheuser (his former student, mentioned above), Nuno Baena as first vice-president, Lauriano das Trinas as secretary, and Honório Leal as treasurer.

The Table

Education was quite up-to-date at the Polytechnic School where Gouvêa obtained his engineering degree and later taught at, although original research was not the primary focus of this institution (Figueirôa, 1997). For instance, the 1882 catalog of its library (Escola Politécnica..., 1882) recorded 41 books on mineralogy, including James Dwight Dana's *System of mineralogy* (1875 edition) and *Crystal systems* by Friedrich Naumann (1872); the 48 books on geology included texts by Hermann Burmeister (1870), Credner (1879), Charles Lyell (1857 and 1875), and a French version of Darwin's *The descent of man* (1871).

However, the syllabi best represent the spirit of that era, strongly influenced by biological and social evolutionism. From 1881 (the year Gouvêa took over classes related to geosciences) until at least 1894, the biological paradigm clearly dominated. The 1881 teaching program does not exhibit such an intense influence, spanning petrography, dynamic geology (volcanos, earthquakes, weathering, and erosion), petrology, "architectural geology" (stratigraphy and paleontological stratigraphy), and historical geology, mainly via a descriptive approach. But the new vision clearly emerged in the subsequent years (from 1882 to at least 1894), in the introductory part of the course: "object of geology: historical synopsis; relations with other sciences; physical-astronomical notions regarding our planet; 'the Earth considered as a cosmic individual, [from] its genesis and development to its present state'; subdivisions of geology" (Escola Politécnica..., 1883, p.3; emphasis added).

With regard to mineralogy, the biological viewpoint is also quite clear: "object of mineralogy: comparative study between mineral individuals and those organized; ... formation, growing and decomposition of minerals; analogies and differences that differentiate these three phases from those observed in the life of an organized being; relations between the laws of heritage and adaptation, and the laws presiding the phenomena of mineral genesis and metamorphosis." In addition to this definition, the syllabus structure also followed the same criteria: "mineral morphology" (including crystallography), "mineral physiology" (encompassing the study of physical and chemical properties), and "mineral taxonomy" (mostly descriptive mineralogy). As Gouvêa indicated in the printed teaching programs, this mineralogical classification belonged to the "improperly named naturalists" school (Escola Politécnica..., 1881).

In his courses at the Polytechnic School, after criticizing the existing main classifications which were exclusively chemical or crystallographic (Escola Politécnica..., 1881), he presented what he intended to be the foundations of a new crystallogenic and crystallotechnic mineral classification, which he called the "natural method," our focus in this article. Note that the term "crystallogenic" was first used by the American naturalist James Dana (1813-1895). After the overview, Gouvêa moved to the study of mineral taxonomy, showing and discussing the set of known minerals according to their respective branches, classes, orders, tribes (or genera), and species (Escola Politécnica..., 1881).

As noted by Hazen (1984), it is important to keep in mind that for more than two millennia the vast diversity of physical properties, modes of occurrence, chemical composition, and crystal structure of minerals defied taxonomic efforts by philosophers and naturalists. Any classification arrangement owes its success to the nature of the unit

of description that circumscribes a species, differentiating one mineral from another and granting it separate recognition and a separate name (Hazen, 1984). The Scottish scientist John Walker (1731-1803) developed and used a chemically-based mineralogical classification system in his classes at the Edinburgh medical school (Eddy, 2008). According to Staples (1981, p.348), a very detailed classification of minerals was developed in 1822-1824 by the German Friedrich Mohs (1773-1839), who is better known for his mineral hardness scale. Mohs developed a natural history system of classifying minerals that included classes, orders, genera, and species and had little use for the “trivial name,” that is, the name of species alone. This was the time of validating what could be called the “first paradigm” in mineralogy, namely “morphology” (Povarennykh, Matvienko, 2014).

The Mohs classification system, which was translated into English by Wilhelm Karl Ritter von Haidinger in 1825, had a profound effect on American mineralogy after James Dana adopted it in the first edition of his *System of mineralogy* (1837); Dana also used Latin names for genera and species, as suggested by Linnaeus. Dana was “particularly concerned with ultimate questions of the creation and advancement of organic life,” beyond the inorganic realm (Sanford, 1965, p.531), and was also “much more interested in the broader questions suggested by a review of the whole science – such as the classification of minerals, theories of crystallogeny, and the morphological relations of species” (Geikie, 1897, p.XIV). Similar issues were present in Gouvêa’s initiative, too.

The mid-nineteenth century was a period of conflict between proponents of “natural history” type classification systems and others like the Swedish chemist Jöns Jakob Berzelius (1779-1848), who believed that chemical composition would form a better basis for classification. In the first (1837) and second (1844) editions of his *System*, as mentioned above, James Dana utilized a natural history classification. In his *Manual of mineralogy* (1848) he began to develop his chemical classification, which replaced the natural history scheme in the third (1850) edition of his *System*. The chemical classification was found to be increasingly advantageous as better chemical techniques for analysis developed, thus becoming the “second paradigm” in mineralogy (Povarennykh, Matvienko, 2014).

Gouvêa’s syllabus reflects this tension to a certain extent and with a slight delay, but his Table was intended to be an original proposal; the research conducted up to this point indicates that it was indeed, as far as I am concerned. It presented 338 different species – not a negligible number, considering it appeared 24 years before X-rays were applied to minerals by Bragg and Bragg in 1913.⁵ Only 40 (11.8%) of the minerals included in his *Table* are no longer accepted or valid species⁶ according to the International Mineralogical Association (IMA).⁷ Moreover, 41 (12.1%) are known under different or updated names. This is partly because of the systems Gouvêa knew and used (such as those by François Beudant or Friedrich Naumann), both of which were present in the Polytechnic School during his undergraduate years.

As previously stated, the “Table of mineral classification” was added as an appendix to the dissertation he presented in 1889 to graduate from the Faculty of Medicine. It is a foldable, unique manuscript sheet of paper of approximately 1,30m x 1,80m, that was manually replicated to be inserted in the printed copies of the dissertation. It is impossible to exactly reproduce it in the pages of a scientific journal.

Gouvêa's involvement with both mineralogy classes and homeopathy could account for the insertion of his "Table of mineral classification" in a medical monograph.

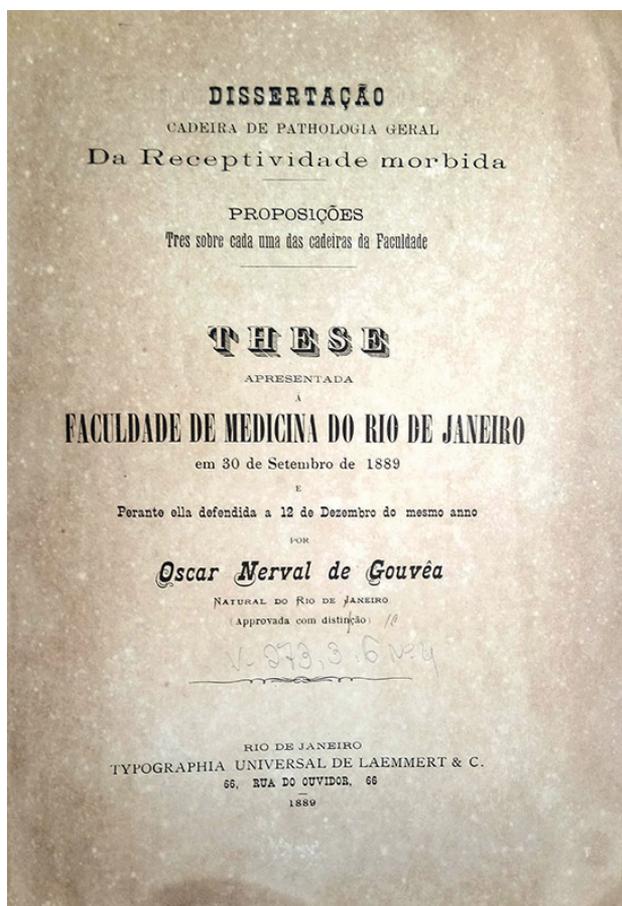


Figure 1: Front page of the monograph *Da receptividade mórbida* (Gouvêa, 1889; copy from the library of the Centro de Ciências da Saúde/Universidade Federal do Rio de Janeiro)

The text of his medical dissertation is impregnated with physical and geoscientific concepts to analyze the functioning of organisms, particularly humans. It also emphasizes the role of mineral deficiencies in the development of diseases. Gouvêa was mainly concerned with nutritional exchanges between the human body and the external milieu, as well as environmental influences, which he called "dynamic conditions for morbid receptivity." The Table is part of the proposition he wrote for the chair of medical mineral chemistry and mineralogy in order to graduate. A two-page explanation of his "new crystallogenic and crystallotechnic mineral classification" precedes the Table. He describes two central assumptions that served as guides (Gouvêa, 1889, p.44):

- 1) The frequency of isomorphic substitutions in certain mineral species and the cases of dimorphism and plesiomorphism render classifications based on chemical character absolutely artificial;

2) The lack of taxonomic subordination in the grouping laws, and the absence of a more general principle in the formation of the superior groups, have been the biggest defects of the classifications named eclectic, crystallographic, and of the false school of pure naturalists.

As we can see, hierarchy (made explicit with the term "subordination") and insufficient regularity of composition or external form were main concerns. In his explanation of the Table, Gouvêa (1889, p.43) made the primacy he attributed to the crystalline structure very clear: "the structure is the only criterion that provided a foundation to arrange the natural classifications established for the animal and plant kingdoms." He continued, explaining that "the crystalline form is the result of an adaptation of the cleavage nucleus [i.e., the crystal cell] – typical of and unique to most species – to the variations in the environment in which a mineral is formed." His classification, as a result, is fundamentally grounded in the crystalline structure, hierarchically established, and sequenced from the more general levels (systems, or "branches," as he called them) to the more particular ones, namely the "species," or minerals as we know them. The approach and resulting arrangement could be considered a sort of "mineral phylogeny." Instead of a common biological ancestor, minerals had a common crystalline "ancestor" (or basic crystal pattern).

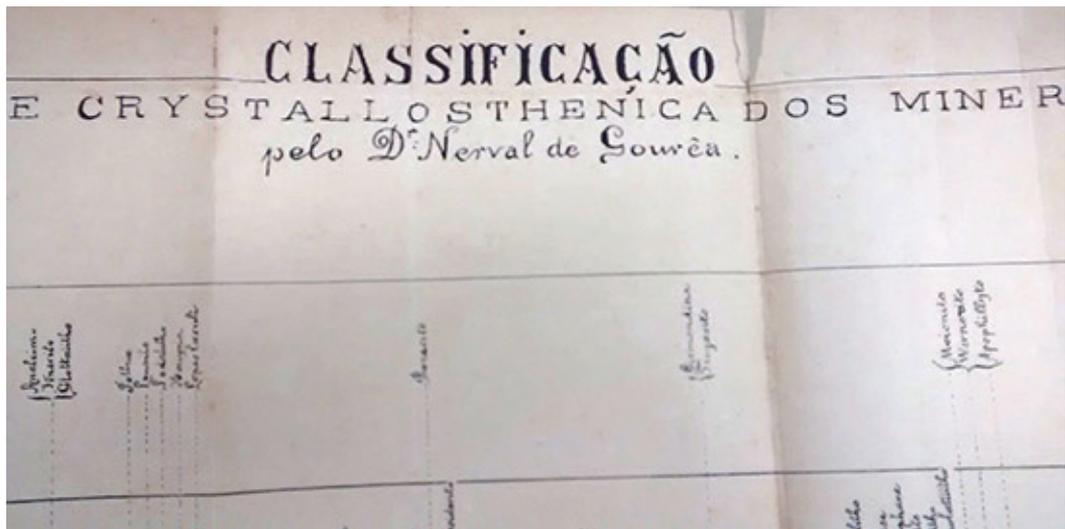


Figure 2: Detail of the "Table of mineral classification" (Gouvêa, 1889, Apêndice)

Broadly speaking, the Table was configured as follows (a detailed transcription is provided in Appendix 1):

- I) Isopolar [homopolar] branch
 - a. Monometric subclass
 - i. Tesseral order
 - b. Dimetric subclass
 - i. Quadratic order
 - ii. Hexagonal order

II) Heteropolar branch

- a. Isometric subclass
 - i. Cubic order
- b. Anisometric subclass
 - i. Tetragonal subclass
 - ii. Trigonal subclass
 - iii. Hexagonal subclass
 - iv. Rhombic subclass

The “order” level was to be defined by the general mineral appearance, what mineralogists call habit. “Genus,” in turn, derived from the type of “cleavage nucleus” – in other words, the form of the unit cell, or approximately the Bravais reticule. Gouvêa considered the unit cell to be the “species hereditary type” that could be modified due to variations in the environment (which today is still accepted), thus resulting in a crystalline series particular to each species. “Species,” which constituted the final and lowest level, was also to be grouped hierarchically according to its “increasing molecular complexity,” which “coincided with the increasing degree of structural evolution and the decreasing degree of density.” In other words, chemical composition would only be considered at the species level.

Consequently, minerals exhibiting the same composition but different crystalline structures (i.e., polymorphs) appear in different branches of the Table. In modern-day chemically-based classifications, however, these minerals are grouped according to anionic composition (e.g., oxides, silicates, sulfates etc.). This feature of Gouvêa’s Table made mineral classification quite logical and easy to use, since the external form (the habit) is one of the first mineral features to be perceived, whether by specialists or lay people, and is linked to and dependent upon the system in which the mineral crystallizes.

Biological comparisons or analogies were abundant, and in a certain sense echoed and updated old organic traditions. For example, Gouvêa referred to crystal reticular plans as “crystalline tissues” that overlapped each other during the process of mineral growth. As expected, he concluded the introductory pages by reinforcing the convenience of his proposed classification. Besides the “bio-evolutionary” tone that could be understood as Spencerian, hierarchy, structure conceived as something rigid, and progress towards the lowest levels are also worthy of note. These aspects could be considered as manifestations of Positivism, which may have inspired and defined his proposal. As Lorenz (2015, p.2) states, “Comte viewed the hierarchy as not only a logical construct but also as a developmental phenomenon. Over time, the sciences appeared in man’s history in a sequence that mirrored the hierarchy. The Law of Classification was incorporated in the secondary education reforms in late nineteenth-century Brazil” in the National Gymnasium (formerly the Pedro II School) – where Gouvêa taught for decades.

It is consequently my opinion that Gouvêa intended to construct his Classification according to well-known Positivist maxims such as “*L’amour pour principe, l’ordre pour base, le progrès pour but*” as well as “Progress is the development of order.” These two sayings from Auguste Comte highlight some of the founding Positivist ideas that were

present surrounding the Brazilian Republic and influenced its construction, and led Gouvêa to choose the reticular, crystalline order as the base for his classification. This attitude is not surprising; for example, Secord (2003, p.170) states the following about nineteenth-century Britain: "Science appeared to encapsulate moral values in its very practice: one of its advantages, through the self-discipline it involved, was ultimately its value for developing character." In the case of Gouvêa, I maintain that values were at the core of his theory.

Final considerations

Various alternative mineral classification systems were proposed during the first half of the nineteenth century, given the lack of agreement on a single system. These systems ranged from extreme crystallographic or natural history positions to more equalized schemes that combined chemical, physical, and crystallographic mineral properties (Hazen, 1984). Even today, in the twenty-first century, Povarennykh (2016, p.30) is still pushing mineralogists and geoscientists to accept a new classification: "Let's develop the new – ontogenic – mineralogical paradigm by thorough investigation of representatives of the two new subkingdom objects: caviclusts (or "nanominerals") and mineraloids as true rightful minerals, along with crystals together." Atencio and Azzi (2017, p.279) have also proposed changes that would make a considerable impact, stating

The conventions for the nomenclature of crystal systems could be more logical. One option would be to use names for all systems that relate to the symmetry elements. The cubic system would be called the tetra-trigonal system, the orthorhombic system would be called the tri-digonal system, the monoclinic system would be called the digonal system, and the triclinic system could be renamed the monogonal system. These four names are logical and technically correct, unlike those that are officially used.

In both of these cases, the crystalline structure is of paramount importance, as in Gouvêa's "Table of mineral classification." In his case, the order was Positivist, finely attuned to his era and place. Classification systems may be considered dry, insipid, or boring, especially when they address inanimate objects such as minerals or stones. However, once they are viewed as proposals within a long line of efforts to frame nature into order, they come to life and allow us to dig deeper into their many layers to glimpse ideas, people, institutions, values, and societies.

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NOTES

¹ A grafia usual atualmente é Gouveia. Nerval de Gouveia Municipal School, estrada Engenho da Pedra, Ramos, Rio de Janeiro, RJ, 21031-030.

² Rua Nerval de Gouveia, bairro Quintino Bocaiúva, Rio de Janeiro, RJ, 21311-110.

³ In this and other citations of texts from Portuguese, a free translation has been provided.

⁴ In the original: “Com ele aprendi a disciplinar meu raciocínio filosófico; dele herdei, finalmente, a cátedra onde tanto brilhou.”

⁵ This number currently stands at around 4,700 mineral species.

⁶ All minerals were checked at <http://www.webmineral.com> (access on: 31 Jan. 2019), <https://www.mindat.org> (access on: 8 Feb. 2019), and old mineralogy manuals.

⁷ The IMA was established in 1959 to control the introduction of new minerals and names of minerals, and to rationalize mineralogical nomenclature.

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APPENDIX CLASSIFICAÇÃO CRYSTALOMORPHICA E CRYSTALLOSTENICA DOS MINERAES*

[In: Gouvêa (1889, Apêndice)]

Organizada pelo Dr. Nerval de Gouvêa**

Ramo – Monocristalocêntricos

I Classe Isopolar

Subclasse Trinométrica

Ordem Tesseral

Gênero Cubo

Iº Grupo – Elementos***

Írídio, Platina, Ouro, Paládio, Chumbo

IIº Grupo – Selenetos, Teluretos e Sulfetos

Clausthalito, Naumannito, Hessito, Altaíto, Galena, Argirose [Argyrodite], Alabandina

* The transcription of the table essentially presents what comprises the axis of the "abscissa." However, in the original manuscript the minerals are also displaced along the axis of the "ordinate," according to the following numbering, from the bottom up: "20-10 9 8 7 6 5 4 3 2 1." This constitutes a lateral displacement reflecting the decreasing density of minerals, as well as the location of their deposits in the earth's crust (surface or subsurface). Such lateral displacement, although relevant, would be difficult to reproduce here.

** The copy in the Biblioteca Nacional (V-265,3,7 n.4) contains the following dedication: "Ao sopesado tio e amigo Thomaz Gomes dos Santos, testemunho de consideração e amizade do Autor." ["To my esteemed uncle and friend Thomaz Gomes dos Santos, as a witness of the Author's consideration and friendship."]. Thomaz Gomes dos Santos was the owner of the *Folha de Domingo* newspaper.

*** The names that were not found are displayed in bold; names that were updated are underlined, and the current name appears between brackets.

- IIIº Grupo – Arsenietos
Skutterudito, Smaltina [Skutterudito], Cloanthito [Niquelskutterudita]
- IVº Grupo – Cloretos e Brometos
Kerargyrito, **Brommeragnito**, **Embolito**, Sylvina [Silvita], Salgema [Halita]
- Vº Grupo – Óxidos
Periclase

Gênero Octaedro

- Iº Grupo – Elementos e Ligas definidas
Prata, Arquerito, Cobre, **Terra**
- IIº Grupo – Óxidos
Cuprito, Senarmontito, Franklinito, Arsenolito, Magnetito, Magnoferrito, Hercynito,
Siderochiamo, Jacobsito, Gahnito, Spinella
- IIIº Grupo – Sulfetos
Phillipsito (Phillipsita-Na), **Limeito**, Siegenito, **Grãmacito**
- IVº Grupo – Cloretos e Fluoretos
Fluorina (Fluorita), Salomônio
- Vº Grupo – Niobatos
Pyrochloro, Pyrrhito
- VIº Grupo – Sulfatos Hidratados
Voltaíto, Alumen

Gênero Rombo do decaedro

- Iº Grupo – Ligas
Amálgamas
- IIº Grupo – Silicatos Hidratados
Analeimo, **Itnerito**, **Glottaitho**
- IIIº Grupo – Silicatos
Granada, **Donadito**, Pollux (Polucita), Leucito, Sodalitho, **Harvyna** (?), Lapislasuli [Lazurita]

Gênero Hexadiedro

- Iº Grupo – Sulfetos
Ullmanosito, Cobaltina, **Disamose**, Pyrite, Hauerite

Subclasse Dimétrica

Ordem Cuadrática

Gênero Cuadroetaedro

- Iº Grupo – Elementos
Estanho
- IIº Grupo – Óxidos
Cassiterita, Anatásio, Braunito, Hausmannito
- IIIº Grupo – Fosfatos e Antimoniatos
Rumeina, Xenotimo
- IVº Grupo – Tungstos e Molybdatos
Scheelitina, Melinose [Wulfenita]
- Vº Grupo – Silicatos Hidratados
Gismondina, **Tanyrito** (?)

Gênero Prisma

- Iº Grupo – Sulfetos
Elasmoze [Nagyagita], Stannita
- IIº Grupo – Cloretos
Calomelanos, Cerasina [Mendipita], Matlockito
- IIIº Grupo – Anidridos
Rutilo
- IVº Grupo – Fosfatos
Chalkolitho
- Vº Grupo – Silicatos
Idocrase [Vesuvianita], Melinophane, **Ichlenito**, Sarcolito, Humboldtianito
- VIº Grupo – Silicatos Hidratados
Meionito, Wernerito [Marialita, Meierita ou Escapolita], Apophillytho

Ordem Hexagonal

Gênero Romboedro

- Iº Grupo – Elementos e ligas
Ósmio Iridífero, Bismutho, Antimônio, Tellurio, Arsênio
- IIº Grupo – Sulfetos
Cinábrio, Millerito, Pyrrargirito, Proustito, Xanthocane
- IIIº Grupo – Teluretos e Arseniats
Tetradymito, Allemontito [Stibarsen]
- IVº Grupo – Óxidos
Oligisto [Hematita], Ilmenito, Coríndon
- Vº Grupo – Óxidos Hidratados
Brucito
- VIº Grupo – Carbonatos
Siderose (Siderita), **Diallogisto**, Mesitita [Magnesita], Calamina [Hemimorfita ou Smithsonita], **Gioberliso**, Dolomia, Calcito
- VIIº Grupo – Azotatos
Nitratina
- VIIIº Grupo – Silicatos
Cronstedtito, **Triedelito**, Eudialyto, Dioptase
- IXº Grupo – Silicatos Hidratados
Larimar [Pectolita], Chabasia, Smectito [Rectorita]

Gênero Prisma

- Iº Grupo – Arseniats e Antimoniats
Nickelina, Breithauptito
- IIº Grupo – Sulfetos
Polybasito, Pyrrhotina, Greenockito, Molibdenito, Covellina
- IIIº Grupo – Óxidos
Gelo
- IVº Grupo – Óxidos Hidratados
Hydrargillito [Gibbsita]
- Vº Grupo – Fosfatos, Arseniats e Vanadatos
Apatito, Pyromorphita, Mimetito, Volbortito, Vanadinito
- VIº Grupo – Sulfatos Hidratados
Alunito, **Alimogeo**, Coquimbrito, Copiapito
- VIIº Grupo – Silicatos
Cerito, Thorito, Pyrosmalito, Siderocrisolito (Fayalita), Milarito, **Katapleito**, Esmeralda, Ettringito

II Classe Heteropolar

Subclasse Isométrica

Ordem Cúbica

Gênero Tetraedro

- Iº Grupo – Elementos
Diamante
- IIº Grupo – Sulfetos
Blenda [Galena], Tetraedrito
- IIIº Grupo – Boratos
Rhodisito, Boracito
- IVº Grupo – Arseniats
Pharmacosiderito
- Vº Grupo – Silicatos
Eulithina, Tritomito, Elvina (Helvina)

Subclasse Anisométrica

Ordem Tetragonal

Gênero Plagiedro

- Iº Grupo – Tungstos e Tantalos
Scheelito, Fergusonito

- Gênero Sphenoedro
 - Iº Grupo – Sulfetos
 - Chalkopyrite
 - IIº Grupo – Silicatos Hidratados
 - Edingtonito

Ordem Trigonal

- Gênero Prisma
 - Iº Grupo – Silicatos Aluminosos
 - Turmalina

Ordem Hexagonal

- Gênero Plasiedro
 - Iº Grupo – Anidridos
 - Quartzo
 - IIº Grupo – Silicatos
 - Phenakito (Fenaquita ou Fenacita)

Ordem Rhombica

- Gênero Sphenoide
 - Iº Grupo – Sulfatos e Fosfatos Hidratados
 - Epsonito, **Stravito**
- Gênero Piramide
 - Smithsonito

Ramo – Dicristalocêntricos

I Classe – Diáxopolar

Subclasse – Ortorrética

Ordem Ortorrômica

- Iº Grupo – Elementos
 - Enxofre
- IIº Grupo – Arseniatos e Antimoniatos
 - Discrase, Leucopyrite, Rammelsbergito, Lollingito
- IIIº Grupo – Cloretos e Fluoretos
 - Nadorito, Mendipito (?), Cotunito, Atacamito, Cryolitho
- IVº Grupo – Sulfetos
 - Bismutina, Chalkosina, **Alarcassito**, Stibina, Ouropimento
- Vº Grupo – Sulfetos Múltiplos
 - Nadenlerz**, **Chiviato**, Geocronito, Wittchenito, Psaturouse [Stefanite], Stromeyerina, Freieslebenenito, Mispickel [Arsenopirita], **Phurnosito**, **Proustisonito**, Wellsito [Harmotome-Ca], Jamesonito, Dufrenoyisito
- VIº Grupo – Óxidos
 - Valentinito, Pyrolusito, Brookito, Zíncito
- VIIº Grupo – Óxidos Hidratados
 - Manganito, Goethito, Diasporo
- VIIIº Grupo – Tantalatos, Niobatos e Titanatos
 - Tantalito, Columbito, Samarskito, **Mongito**, Polycrase, **Archynito**, **Montalcito**
- IXº Grupo – Sulfatos
 - Caledonito, Leadthilito, Anglesito
- Xº Grupo – Carbonatos
 - Cerussito, Witherito, Stroncianito, Alstonito, Aragonito
- XIº Grupo – Fosfatos e Arseniatos
 - Olivenito, Adamina, Zwieselito, Triplito, Liebethenito, Triphyllina, Daphenito [Chamosita], Euchroito, Scorodito, Childrenito, Wagnerito, Wavellito, Herderito, Uranito, Ambligonito
- XIIº Grupo – Silicatos Não Aluminosos
 - Chondrodito, Gadolinito, Willemito, Peridoto [Forsterita], Lievrito [Ilvaíta], Wohlerito, Enstatito, Hipersthenito

- XIIIº Grupo – Silicatos Aluminosos
Clorito, Estauroilito, Sillimanito, Zoisito, Andalusito, Mica, Antophylito, Topázio, Cordierito
- XIVº Grupo – Silicatos Hidratados
Talcó, **Leaganito**, Dewalquito [Ardenita], **Frenito**, Brandisito [Clintonita], Carpholito, Pyrophilito, **Pholerito**, **Foresito**, Harmotome, Thomsonito, Okenito, Epistilbito, Christianito [Harmotome], Stilbito, Mesolypo
- XVº Grupo – Sulfatos Hidratados
Mirabilito, Polyalito, Goslarito
- XVIº Grupo – Oxalatos
Conistonito

Subclasse – Clinorreticular

Ordem Clinorrômbica

- Iº Grupo – Sulfetos
Plagionito, Miargyrito, Feuerblenda [Pirostilpinita], Rittingerito [Xantocanita], Kermes, Realgar
- IIº Grupo – Cromatos e Sulfatos
Lanarkito, Crocoisa, Vauquelinito, Linarito, Gypsito, Melanterito
- IIIº Grupo – Carbonatos
Malachito, Azurito, Barytoalcalito, Dawsonito
- IVº Grupo – Fosfatos, Arseniatos e Azotatos
Monazita, Aphanese [Clinoclase], Lunnito [Pseudomalaquita], Hureaulito, Klaprothina [Emplectita, Lazulita e, ou Wittichenita], Erythrina, Liroconito, Pharmacolito, Vivianito, Nitro
- Vº Grupo – Silicatos Não Aluminosos
Achmito [Aegirina], Grünerito, **Rhadonito**, **Keithanito**, Spheno [Titanita], Diopsídio, Sahlito [Piroxênio], Tremolita, Actinoto, Wollastonito
- VIº Grupo – Silicatos Aluminosos
Hedenbergito, Piemontito, Orthito [Alanita], Augito, Hornblenda, Triphane [Espodumênio], Euclase, Epidoto, Orthoclase, Petalito
- VIIº Grupo – Silicatos Hidratados
Dillage [Diopsídio], Allanito, Ottrelito, **Monsandrito**, Datolitho, Brewsterito, Heulandito, Laumontito, Scolesito

Ordem Clinoédrica

- Iº Grupo – Carbonatos Hidratados
Trona, Hydromagnesito, Gaylussite
- IIº Grupo – Boratos e Sulfatos Hidratados
Borax, Sassolina, Cyanose [Cianotriquita]
- IIIº Grupo – Arseniatos e Fosfatos Hidratados
Roselito, **Montebrasito**
- IVº Grupo – Silicatos
Disthenio [Cianita], Axinito, Babingtonito, Leucophane, Damburito, Anorthito, Labradorito, Oligoclase, Albita