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The History of Mineralogy in Brazil – from prehistoric times to oxycalciomicrolite

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We are grateful to Dr. Herwig Pelckmans for his thoughtful and patient review of this manuscript.

“Many people who are reported in this work, and who no longer belong to this life plan, had a messianic dedication to minerals. This text is dedicated to them.”

Brazil is well known for its mineralogical diversity. A little over 19% of all known minerals to date have been found in Brazil so far (NEVES & ATENCIO, 2019).

The knowledge of minerals in Brazil, since before the Portuguese invasion, until the present times, went trought several phases, such as the one in which the past inhabitants were concerned only with the aesthetic and practical value of these substances; the arrival of the colonizers, who started to worry about their economic value (Gold and Diamond cycles), wants to continue at the present day, until the phase when technological value matters (use as strategic minerals and the nuclear industry).

For a better temporal understanding of this long History it is necessary to couple events with the classic development of historical times.

Didactically, we can subdivide History in the following phases:
> Paleolithic Period (chipped Stone Age) – 7 million years before Present – 10,000 years ago (near passage Late Pleistocene-Holocene - first hominids – agricultural evolution);
> Neolithic Period (polished stone Age) – 10,000 – 5,000 years ago (agricultural evolution – metallurgy);
> Age of Metals (iron, copper and bronze) – 5,000 – 3,500 years ago (metallurgy – emergence of writing);
> Old Age – 3,500 years ago – 476 AD (emergence of writing – fall of Roma);
> Middle Ages – 476 AD – 1453 AD (fall of Roma – fall of Constantinople);
> Modern Age - 1453 AD – 1789 AD (fall of Constantinople – fall of Bastille (French Revolution));
> Contemporary Age – 1789 AD – current days.

Brazil has a very recent history, since the Portuguese arrived here in 1,500 AD, when the colonization of their lands began, therefore historically in the throes of the Middle Ages and the beginning of the Modern Age.

Before the Portuguese landed here, our homeland was inhabited by innumerable indigenous peoples, who lived freely and, certainly, somehow used, in their daily lives, the natural resources that exist here.

Since 10,500 years ago what would become the current Brazilian territory was already inhabited by hunter-gatherer populations, which were distributed from the Amazon to the extreme South of the Pampa. In those times, at least three great cultural traditions associated with stone artifacts (scrapers, knives, and arrowheads) were established in these lands: Umbu in the South, “Lagoa Santa” in the territory corresponding to Minas Gerais state (where the remains of the oldest Homo sapiens in Brazil were found, including the famous skull of Luzia, about 11,500 years before Present, in “Lapa Vermelha IV”) and Arapiraca, in the Northeast and Midwest.

Only about 5,000 years ago, humans arrived on the coast. But the human presence in Brazil is certainly older. The Santa Elina shelter, in the Mato Grosso state, near the Cuiabá river, dates from 25,000 years before Present. At the sites of “Serra da Capivara”, São Raimundo Nonato, Piaui state, the records are from 20,000 years ago. There famous rock paintings in which the hominids used minerals such as malachite ($Cu_2^{+2}(CO_3)(OH)_2$), hematite (Fe_2O_3), pyrolusite ($Mn^{+4}O_2$), graphite (C), and others, having as main example the exceptional exhibitions of the “Boqueirão da Pedra Furada” lair (Figure 1).

In the region between Uruguaiana and Itaqui, Rio Grande do Sul state, it is quite common to find arrowheads, scrapers, among other tools, made in quartzite, and also quartz (agate and chalcedony varieties (SiO_2)), common geological materials in those places. This lytic industry is related to the Laranjito site (Umbu tradition) established in the region about 12,000 years ago (ARAÚJO, 2015).

Figure 1 – paintings of Boqueirão da Pedra Furada lair, "Serra da Capivara", São Raimundo Nonato, Piaui state, Brazil (Fundham - photo: Adri Felder/Argofoto); malachite, hematite and pyrolusite (Geology and Mineralogy Laboratory at ULBRA collection) and graphite (Paulo Neves collection – photographies: Luciano Valério).

The past inhabitants of Brazil made various lithic objects from minerals or their derivatives, mainly amazonite (microcline variety (KAlSi3O8)), jadeite (Na(Al,Fe3+)Si2O6), nephrite (actinolite variety - □Ca2Mg4.5-25Fe2+0.5-2.5Si8O22(OH)2)), graphite, hematite, malachite, sillimanite (Al2SiO5), opal (SiO2.nH2O), quartz and its varieties (chalcedony, aventurine, flint, jasper and cornaline), as well as rocks such as amphibolite, basalt, diabase, diorite, steatite, phyllite, gabbro, gneiss, granite, quartzite and schist (NEVES et al., 1990; CORNEJO & BARTORELLI, 2014; LOPES, 2017).
Another interesting fact is the use of gold (Au) as a weight fishing lines, due to its high density, by the indigenous peoples (Tupiniquins) of the coast of São Paulo state, as reported by Staden (1557) and later by Anthony Knivet, 1591 (Figures 2-3).

Figure 2 – amazonite and jadeite (Luiz Alberto Dias de Menezes Filho collection – photographies: Tatiana Menezes), nephrite (Dr. Rob Lavinsky collection (Arkestone) & photo), sillimanite and "chalcedony" (Geology and Mineralogy Laboratory at ULBRA collection), quartz and opal (Paulo Neves collection – photographies: Luciano Valério).

Figure 3 – amphibolite (geology.com), basalt, diabase, gneiss and granite (Paulo Neves collection), steatite and gold (Geology and Mineralogy Laboratory at ULBRA – photographies: Luciano Valério), diorite, phyllite, gabbro, quartzite and schist (Wikipedia.com).

From then on, the development of Mineralogy in Brazil took place in a chronological concatenation of events allied to peoples.

The oldest historical mineralogical record in Brazil is due to the Spaniard, Felipe de Guillén (born in Sevilla, 1487, died in Porto Seguro, 1571 (?)) (Figure 4) who suggested the occurrence of emerald (green variety of beryl ($Be_3Al_2Si_6O_{18}$)) in the so-called "Serra Resplandescente" (Glowing Mountain), a place full of emeralds.

Figure 4 – explorer Felipe de Guillén caricature (Wikimedia commons) and "emerald" crystals (Geology and Mineralogy Laboratory at ULBRA collection – photo: Luciano Valério).

This was a legendary geological formation, result of popular imagination, a place that was looked for many explorers, but a was never found or discovered. The indigenous peoples called it "Serra de Sabarabuçu" and, perhaps, it corresponds to "Serra da Piedade", currently in the municipality of Caeté, near Belo Horizonte, Minas Gerais state (Figure 5).

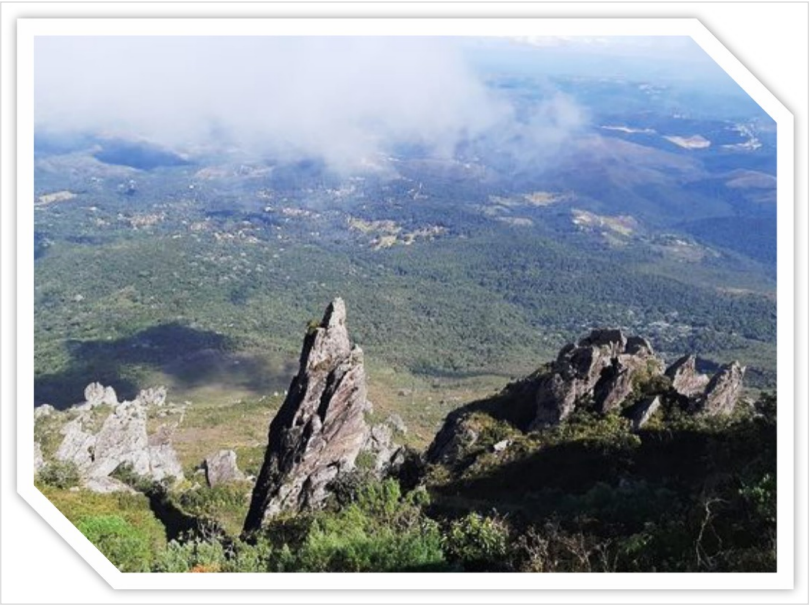

Figure 5 – panoramic aspect of the "Serra da Piedade", near Belo Horizonte, Minas Gerais state (most likely ancient "Serra Resplandescente") (TripAdvisor).

Legends like this are what must have been one of the main factors that led the white man to make inroads in the "Sertão", in search of easy wealth, like the Eldorado of Spanish America.

The purpose of this work is to pay a fast homage to these people, give a short biography and point out some of their deeds and accomplishments.

The first historian to describe expeditions in the Brazilian Highlands ("Sertão") was the Portuguese Pêro de Magalhães Gândavo (born and died in Braga, 1540-1580) (Figure 6). He talked about the occurrence of gold in the region corresponding to the present Minas Gerais state. His main explorations were limited to the coastal region of Brazil, from Olinda to São Vicente, respectively in Pernambuco and São Paulo states.

Figura 6 – portrait of Pêro Magalhães Gândavo (Reddit) and gold in the matrix (Luiz Englert Museum collection - IG-UFRGS – photo: Luciano Valério).

As mentioned by Neves et al. (2013) and Cornejo and Bartorelli (2014), the history and development of Brazilian mineralogy depended on a large number of factors and events. Some of them are the use of these substances for personal adornment, artifacts used in daily life and in rituals, the search for noble metals by the Portuguese Crown and by the scouts and explorers ("bandeirantes"), the discovery of large quantities of gold and diamond in Minas Gerais during the Colonial Period and the great scientific expeditions by European naturalists and travelers.

Other factors and events include the escape of the Portuguese Royal Family to Brazil (1807), fleeing the Napoleonic troops, that eventually led to the fouding of the National Museum in Rio de Janeiro state (1818) and the posterior establishment of the School of Mines and Metallurgy in Ouro Preto, Minas Gerais state (1876).

The first publication on scientific bases at the time was the work of Portuguese Gabriel Soares de Souza (born in Ribatejo, 1540, died at the headwaters of Paraguaçu river (Bahia state), 1591), called "Tratado Descriptivo do Brasil", published in 1587. He was a historian and farmer and made the first interferences about to possible occurrence of copper (Cu), iron (Fe), "amethyst", "garnet" and gold in the Brazilian Sertão in regions that correspond to the present state of Bahia. Iron, was possibly hematite, because there is no record of these native metal in Bahia (Figures 7-8).

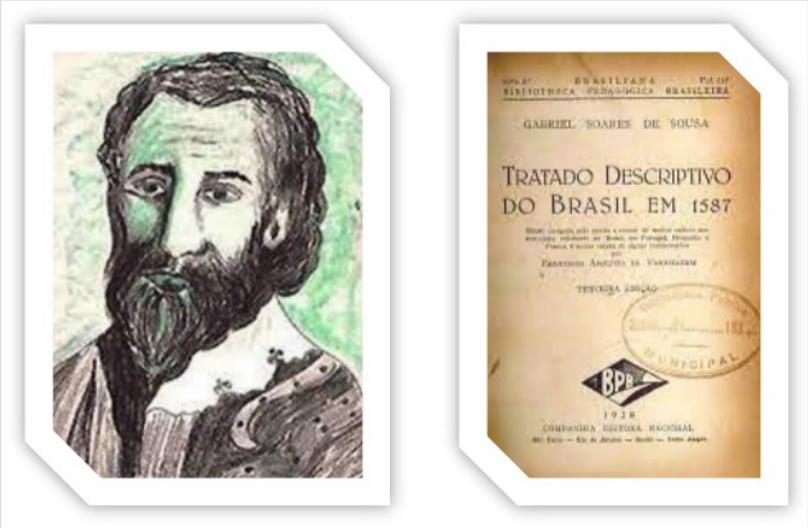

Figure 7 – Gabriel Soares de Souza caricature (alohetron.com) and cover of "Tratado Descriptivo do Brasil" (Cia. Ed. Nacional, 1938).

Figure 8 – hematite (Geology and Mineralogy Laboratory at ULBRA collection), copper, "amethyst", "garnet" and gold (Paulo Neves collection – photographies: Luciano Valério).

In the captaincy of São Paulo, father and son, both with the same names and residents in Santos village (Afonso Sardinha "the old", unknown date of birth and died in Jaraguá farm (São Paulo state), 1616 and the son, called "the guy", unknown date of birth and who died, 1604), who were experienced in mining, discovered native gold in 1580 in Itaí stream, Jaraguá range, and in 1589, magnetite ($Fe^{2+}Fe^{3+}2O3$) iron deposit in Araçoiaba hill, Ipanema (Iperó, São Paulo state). They were also responsible for the establishment of the first metallurgy plant in Brazil. Sardinha was a Portuguese scout and explorer, Indian hunter and perhaps the first to traffic-slaves from Angola to Brazil. The Sardinha's house is still preserved and can visited in the "Parque Estadual do Jaraguá", São Paulo city, a place known for gold prospecting (Figure 9).

Figure 9 – Afonso Sardinha "the old" caricature (Rodovit PT), his house in "Parque Estadual do Jaraguá" (PIRITUBANET) and magnetite (Paulo Neves collection – photo: Luciano Valério).

Anthony Knivet (born about 1560, and died probably in 1649) was a British adventurer who lived on the coast of Santos village (region of Ilhabela and Sapucaí river) together with the Indians and wrote a book about his strange misfortunes where he reports his passage through Brazil. He found abandoned Indian huts fishing weights that were made of gold and adornments made of emerald and possibly diamond (Figure 10).

Figure 10 – portrait of pirate Anthony Knivet and cover of his book (dicasdeilhabela.com.br).

During the 17th century scouts and explorers finally discovered gold on a large scale in Brazil. During this century and the subsequent times up to 1888 when slavery was abolished the African Negro performed horrible forced labor in Brazilian mines. Many slaves were the victims of unhealthy work conditions, exhaustion, drowning, burying and many types of accidents (Figure11).

Figure 11 – slaves in gold mining in Brazil (esquerdadiario.com.br).

The statesman José Bonifácio de Andrada e Silva is considered the father of Brazilian Mineralogy (born in Santos, São Paulo state on July 13, 1763 and passed away on April 6, 1838 in Niteroi, Rio de Janeiro state). He was the first Brazilian to describe a new mineral species, petalite ($LiAlSi_2O_{10}$) while in Sweden (Figure 12).

Figure 12 – portrait of José Bonifácio de Andrada e Silva (bonifacio.net.br) and petalite (Geology and Mineralogy Laboratory at ULBRA collection – photo: Luciano Valério).

Besides being known as a notable statesman and industrial chemist he is also famous for describing three others new minerals: spodumene ($LiAlSi_2O_6$), cryolite (Na_3AlF_6) and "scapolite" (the scapolite group is constitued by marialite ($Na_4Al_3Si_9O_{24}Cl$), meionite ($Ca_4Al_6Si_6O_{24}CO_3$) and silvialite ($Ca_4Al_6Si_6O_{24}SO_4$) (Figure 13), all also from Sweden.

Figure 13 – spodumene and cryolite (Geology and Mineralogy Laboratory at ULBRA collection – photographies: Luciano Valério) and "scapolite" (Cornejo; Bartorelli, 2014 – Andrea Bartorelli collection – photo: Marcelo Lerner).

The mineral andradite (Ca3Fe3+2Si3O12), a nesosilicate was named in his honor of the American mineralogist James Dwight Dana (born in Utica, 1813, died in New Haven, 1895) in 1868 (Figure 14). Bonifácio, who originally studied at the University of Coimbra, Portugal, performed most of his scientific work in Europe. Upon his return to Brazil, he was mainly concerned with the governing of the country.

Figure 14 – portrait of James Dwigth Dana and andradite (Wikipedia.org).

During his stay in Europe, he traveled widely and collaborated, worked and studied with many well known and renowned scientists of the time. Among them we shall name Domenico Vandelli (born in Padua, 1735, died in Lisbon, 1816), Antoine François de Fourcroy (born and died in Paris, 1755-1809), René Just Haüy (born in Saint Just, 1743 and died in Paris, 1822), Jean-Pierre-François Guillot Duhamel (portrait no avaliable) (born in Teraka, 1767 and died in Paris, 1847), Abraham Gottlob Werner (born in Oslecznica, 1749 and died in Dresden, 1817), Friedrich Mohs (born in Gernrode, 1773 and died in Agordo, 1839), Andrés Manuel Del Rio (born in Madrid, 1764 and died in Mexico city, 1849), Wilhelm von Eschwege (born in Hesse an der Aisch, 1781 and died in Kessel-Wolfsanger, 1855), Alessandro Volta (born and died in Como, 1745-1827), Johann Gottlieb Gahan (born in Hälsingland, 1745 and died in Falun, 1818), Peter Christian Albidgaard (born and died in Copenhagen, 1740-1811), Carl Alex Arrhenius (born and died in Stockholm, 1757-1824), Friedrich Heinrich Alexander (Baron von Humboldt) (born and died in Berlim, 1769-1859), Christian Leopold von Buch (born in Stolpe an der Oder, 1774 and died in Berlim, 1853) and Peter Jacob Hjelm (born in Sunnerbo Härad, 1746 and died in Stockholm, 1813) (Figure 15). He consolidated his knowledge in natural sciences and especially in mineralogy (CORNEJO; BARTORELLI, 2014).

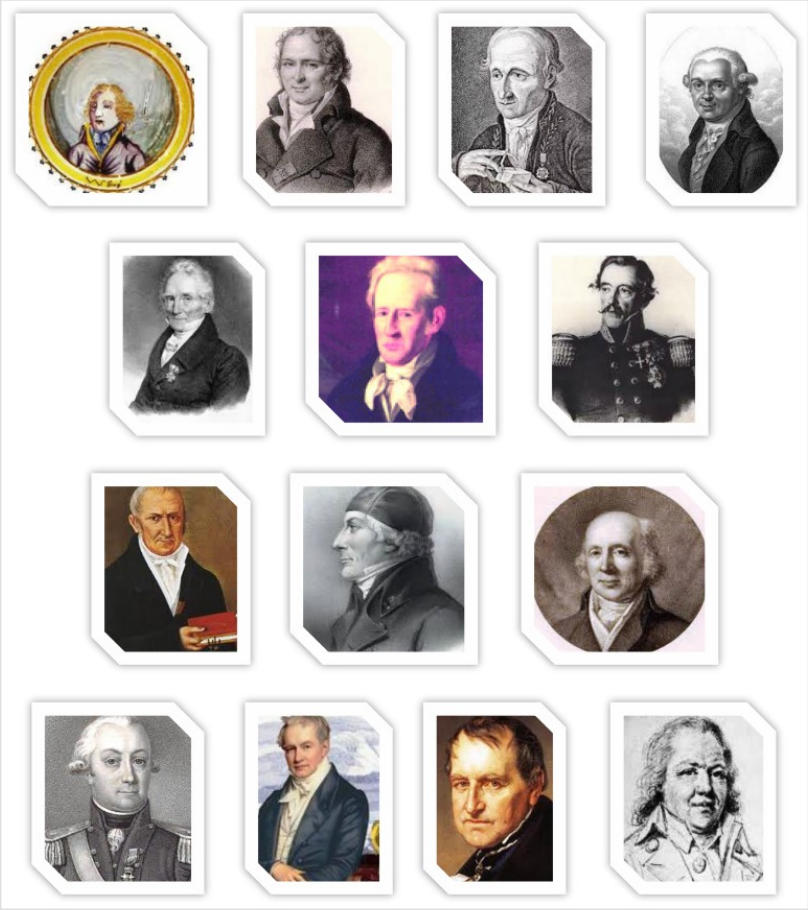

Figure 15 – portraits of Domenico Vandelli, Antoine François de Fourcroy, René Just Haüy, Abraham Gottlob Werner, Friederich Mohs, Andrés Manuel Del Rio, Wilhelm von Eschwege, Alexandre Volta, Johann Gottlieb Gahan, Peter Christian Albidgaard and Carl Alex Arrhenius (Wikipedia.org); Friederich Heirich Alexander (Humboldt) (bbc.com), Christian Leopold von Buch (prebook.com) and Peter Jacob Hjelm (geni.com).

The first type-mineral of Brazil (chrysoberyl ($BeAl_2O_4$)) was described in 1789 by the German geologist Abraham Gottlob Werner, emeritus professor of geology and mineralogy of the Academy of Mineralogy of Freiberg, Baden-Württenberg. It was found in alluvions of the region of Araçuaí in Minas Gerais state (Figure 16). Its name comes from the Greek in reference to its color and because it is similar to the mineral beryl (χρυσός = golden, and βήρυλλος = beryl).

Figure 16 – portrait of Abraham Gottlob Werner (estratificante blogger); chrysoberyl (IGc-USP Museum collection – photo: Marcelo Lerner).

The miner José Vieira Couto (born and died in Diamantina, 1752 and 1827, respectively) (portrait no avaliable), in 1798 indicated the possible occurrence of lead (possibly galena (PbS)), diamond (C), copper (possibly chalcopyrite), platinum (Pt), tin (possibly cassiterite (SnO_2)) and gold (Figure 17) in Serro Frio, Abaeté, Diamantina (Arraial do Tijuco), Conceição do Mato Dentro and Ouro Preto, all in Minas Gerais state. At the time, there was interest by the Crown of Portugal in encouraging attempts to implement mining techniques and ore smelting in Brazil and Portugal, in order to improve economic and social conditions in the Kingdom. One of Vieira Couto's main endeavors was to improve economic and extractive techniques, especially in diamond mining.

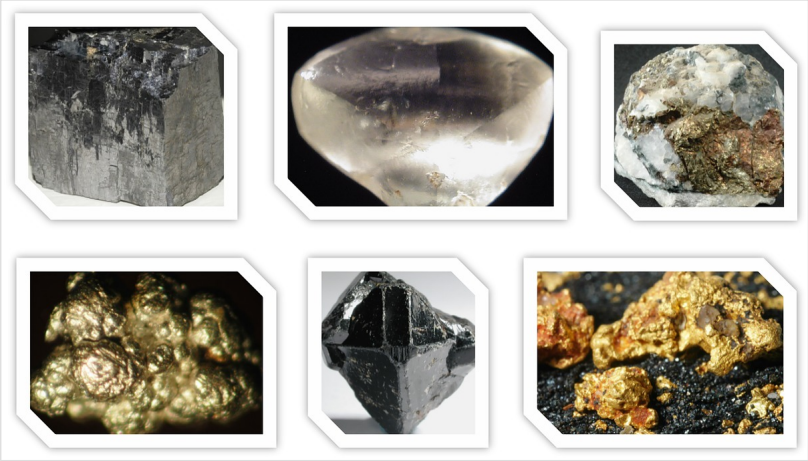

Figure 17 – galena, diamond, chalcopyrite, platinum and cassiterite (Paulo Neves collection) and gold (Ruy Philipp collection – photographies: Luciano Valério).

José de Sá Bettencourt Accioly (born and died in Caeté, 1754/55 and 1828, respectively) mentioned in 1822 the occurrence of niter (KNO_3), crocoite ($PbCrO_4$) and specularite (hematite variety), in the region of Catas Altas in Minas Gerais state (Figure 18).

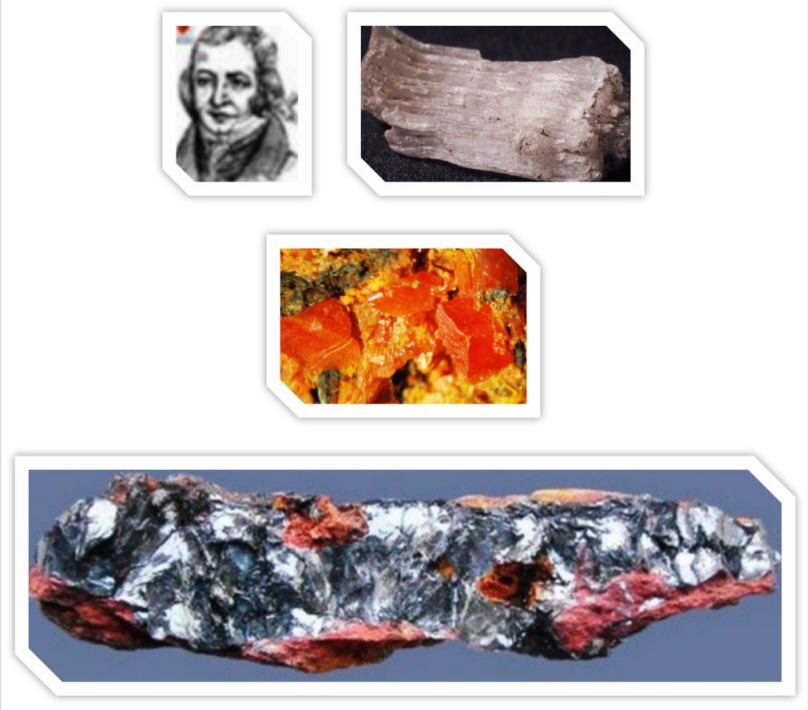

Figure 18 – José de Sá Bettencourt Accioly caricature (geni.com); niter and crocoite (Geology and Mineralogy Laboratory at ULBRA collection – photographies: Luciano Valério) and specularite - variety of hematite (Rui Nunes collection – photo: R. Nunes).

The German naturalists Karl Friedrich Phillipp von Martius (born in Erelangen, 1794 and died in Münich, 1868) and Johann Baptiste Ritter von Spix (born in Hüchstadt an der Aisch, 1781 and died in Münich, 1826) related the presence of a variety of topaz (Imperial topaz) ($Al_2SiO_4(F,(OH)_2$) in Vila Rica (currently Ouro Preto) in Minas Gerais state (Figure 19).

Figure 19 – portraits of Karl Friedrich Phillipp von Martius and Johann Baptiste Ritter von Spix (Wikipedia.org); "Imperial topaz" (Geology and Mineralogy Laboratory at ULBRA collection – photo: Luciano Valério).

They were also the first scientists to visit the iron meteorite (octahedrite I) called Bendegó found in 1784 in Monte Santo (present day municipality of Uauá),

in the “Sertão” of Bahia state (Figure 20).

Figure 20 – portrait of Bendengó meteorite in the lobby of National Museum of Rio de Janeiro (Cornejo; Bartorelli, 2014).

The voyage of the naturalists to Brazil was supported by the Academy of Sciences of Bavaria and had the purpose to establish botanical, zoological and mineralogical collections of the most Imperial provinces of our country.
Were present at the wedding of the Grand Duchess Carolina Josefa Francisca Fernanda de Habsburgo-Lorena (Dona Leopoldina) (born in Vienna, 1797, died in Rio de Janeiro, 1826), who was also a very important amateur collector of minerals at the time. Her collection was one of the most significant at the time and was later incorporated into the collection of the National Museum of Rio de Janeiro (Figure 21).

Special emphasis should be placed on the Royal Family collection, that consisted of thousands of diamonds and other minerals, the most beautiful known so far, that were found throughout the Brazilian territory. Also noteworthy is the Werner collection acquired by the King of Portugal (Dom João VI), which had at the time about 3,200 specimens, and represented all the minerals known until then. This collection was brought to Brazil by the Royal Family.

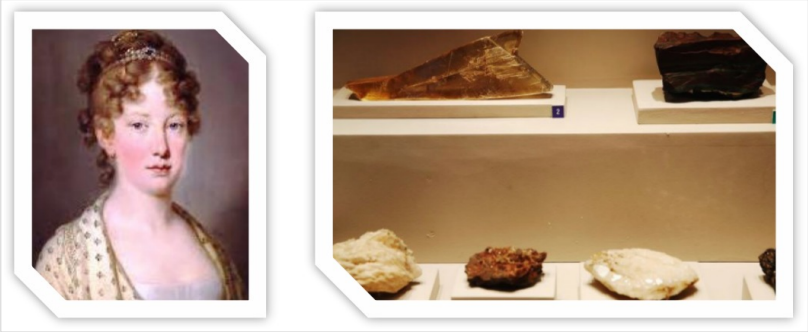

Figure 21 – portrait of Dona Leopoldina, Empress of Brazil and part of Werner collection (Wikipedia.org and EBC-agência Brasil).

Her son, Emperor Dom Pedro II (born in Rio de Janeiro, 1825, died in Paris, 1891) also mineral collector, had in his collection beautiful examples of minerals gifted by the American geologist William Earl Hiden (born in Providence, 1853, died in Newark, 1919) and another collection from the royal house of Russia. In its collection there was an emerald from Muzo, Colombia, and, which today is found in the British Museum of London. An immense amethyst geode from Rio Grande do Sul state was also a very admired piece of the collection. The collection of the Empress Leopoldina was inherited by the Prince Dom Pedro Augusto de Saxe-Coburgo-Gotha e Bragança (born in Rio de Janeiro, 1866 and died in Tullin an der Donau (Austria), 1934), your nephew and grandson of Dom Pedro II, Emperor of Brazil. The Prince was graduated in Civil Engeenering, but he became a fruitfull and proficient in mineralogy, having left several publications (NEVES et al., 2013; NEVES; IONESCO, 2014; CORNEJO; BARTORELLI, 2014) (Figure 22).

Figure 22 – portraits of Dom Pedro II and Prince Dom Pedro Augusto de Saxe-Coburgo-Gotha e Bragança (Wikipedia.org).

Wilhelm Ludwig von Eschwege was a German geologist and mining engineer who occupied the position of Director of the "Real Gabinete de Mineralogia do Brasil" in 1810. He founded the iron smelter in Congonhas do Campo, Minas Gerais state and began its industrial operation in 1811. During his stay in Brazil (1809-1821) he gathered a large mineralogical collection that can be seen in the Technical University of Clausthal Museum, Germany (NEVES; IONESCO, 2014; CORNEJO; BARTORELLI, 2014).

Four minerals new to science and found in Brazil were described in the 1792 and 1884: euclase, palladium, joséite and palladinite.

Euclase (BeAlSiO4(OH)), was described in 1792 by the French mineralogist René Just Haüy (Figure 15) (Delamétherie, 1792 and Haüy in Delamétherie, 1797), considered the Father of Crystallography and who enunciated the Law of Rationality of Indices.

Palladium (Pd) was described in 1804 by the English chemist and mineralogist William Hyde Wollastom (born in Dereham, 1766, died in Chislehurst, 1828), which observed a substance found with crude platinum in 1804. In 1805 named it as palladium (Wollaston, 1804, 1805).

Joséite (Bi4TeS2) was described in 1853 by the Austrian-Polish mineralogist Gustav Adolph Kengott (born in Breslau, 1818, died in Lugano, 1897), emeritus professor of the Zurich University, author of others new minerals, among them enstatite. The first mention of the occurrence of bismuth telluride in Brazil was presented in 1832 by Wilhelm von Eschwege, for a material from Furquim's gold veins, in Mariana, Minas Gerais state.

The name joséite (josït) was given, possibly by Kengott, in 1853, and it is an allusion to the São José mine, in the same municipality.

According to Ferraz, 1928, the mineral occurs in the sediments of the São José and São João do Morro mines.

Peacock, 1941 found that there were two species of joséite, one with formula Bi4+xTe1-xS2 and the other with formula Bi4+xTe2S.

Thompson, 1949 named the material with the first formula as Joséite-A, and the other as Joséite-B. The two analyzes of Joséite from the São José mine (DAMOUR, 1844 and GENTH, 1886) correspond to Joséite-B. Although the literature cites Joséite-B for the Maria Lázara gold deposit, in Goiás state (PULZ et al., 1992), there are no chemical analyzes. With regard to the Borborema Mineral Province, in Rio Grande do Norte (SOUZA NETO et al., 2008), the chemical analyzes presented clearly show that it is Joséite-A, but the formula was incorrectly calculated, suggesting that it was Joséite-B. Since the status of the species is questionable by IMA, these minerals should not be included among the minerals validated for Brazil.

Palladinite (Pd,Cu)O was described in 1857 by the American botanical and mineralogist Charles Upham Shepard (born in Little Compton, 1804, died in Charleston, 1886). He was also a meteorite scholar and collector. (Figure 23).

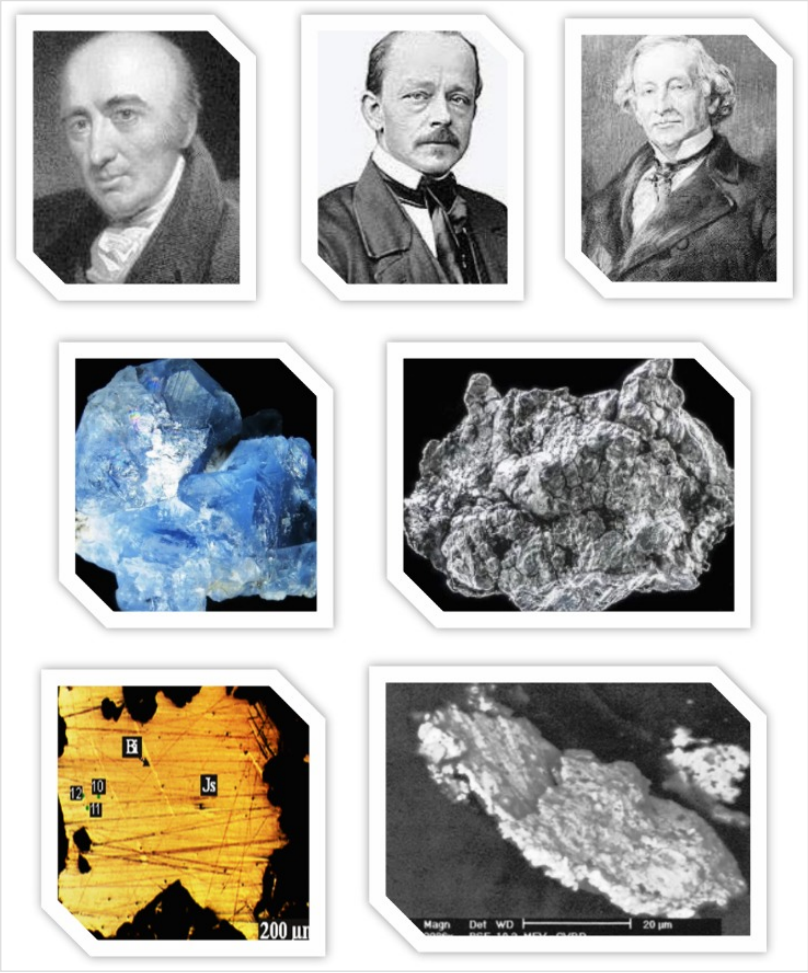

Figure 23 – portraits of René William Hyde Wollaston, Gustav Adolph Kengott and Charles Upham Shepard (Wikipedia.org); euclase (Edson Ferreira dos Santos collection & photo), palladium (Paulo Neves collection – photo: Luciano Valério), joséite-B (Js - Mineralium Deposita - Souza Neto et al., 2008) & photo) and palladinite (SEM - Mineralogical Magazine - Cabral et al., 2001 – photo: Rogério Kwitko -Ribeiro).

Augustin-Alexis Damour (born and died in Paris, 1808-1902) was a French mineralogist and diplomat who describe the sixth type mineral of Brazil, goyazite

(SrAl3(PO4)2(PO3OH)6, found in 1894 (Damour, 1894) in Ribeirão do Inferno claim, near Diamantina in Minas Gerais state (Figure 24).

Figure 24 – portrait of Augustin Alex Damour (Wikipedia.org) and goyazite (Cornejo; Bartorelli, 2014 – Luiz Alberto Dias de Menezes Filho collection – photo: Thales Trigo).

The Austrian petrologist, Eugen Hussak (born in Stelemark (Wildon), 1856, died in "Caldas", 1911) with the English mineralogist George Thurland Prior (born and died in Oxford, 1862-1936, respectively), described in 1895 the new mineral zirkelite ((Ti,Zr,Ca)O2-x).

In 1897, the same scientists described others two new minerals derbylite and tripuhyite.

Derbylite (Fe3+Ti3Sb3+O13(OH)) to honor the American/Brazilian geologist Orville Adalbert Derby (born in Kellogsville, 1851, died in Rio de Janeiro, 1915), director of "Serviço Geológico e Mineralógico do Brasil" and tripuhyite (Fe3+Sb5+O4), found in Trupuí, Ouro Preto, Minas Gerais state, in alluding to the location where it was found.

In 1898, the same scientists defined another Brazilian type species called senaite (Pb(Ti,Fe,Mn)21O38), to honor the Brazilian geologist Joaquim Cândido da Costa Sena, director of "Escola de Minas e Metalurgia de Ouro Preto The mineral it was found in Datas.

In 1900 the type mineral florencite-(Ce) (CeAl3(PO4)2(OH)6) was defined, it was found in Diamantina (Figure 25). All of these minerals were found in the Minas Gerais state.

Figure 25 – portraits of Eugen Hussak, George Thurland Prior, Orville Adalbert Derby (Wikipedia.org) and Joaquim Cândido da Costa Sena (Cornejo; Bartorelli, 2014 – drawing: Mei Zijian); zirkelite (Cornejo; Bartorelli, 2014 – Paulo Roberto Amorim dos Santos Lima collection – photo: Marcílio Guazzinelli), derbylite (Muséum national d'Histoire naturelle de Paris – photo: Cristiano Ferraris), tripuhyite (Luigi Chiappino collection – photo: Sebastian Axt), senaite (La Fuente et al., 2015 – RRUFF Project – ID:R060644) and florencite-(Ce) (Cornejo & Bartorelli, 2014 - Luiz Alberto Dias de Menezes Filho collection – photo: Thales Trigo).

In 1906, Hussak described the type mineral gorceixite, (BaAl3(PO4)(PO3OH)(OH)6), in honor of the French geologist Claude-Henri Gorceix (born and died in Saint Denis des Murs, 1842-1919, respectively), founder of the School of Mines and Metallurgy in Ouro Preto, Minas Gerais state (Figure 26).

Figura 26 – portraits of Claude-Henri Gorceix (ufop.br); School of Mines and Metallurgy of "Ouro Preto" (pinterest.com), Minas Gerais state and gorceixite (IGc-USP Museum collection – photo: Thales Trigo).

Besides being the first director, Gorceix also taught geology, mineralogy, chemistry and physics. His mortal remains were brought from France in 1973 and are resting in the yard of the Gorceix Museum of the School of Mines and Metallurgy of "Ouro Preto".

The first Brazilian to formulate a type mineral of Brazil was the Professor Djalma Guimarães (born in Santa Luzia das Velhas, 1894, died in Belo Horizonte, 1973), who described the mineral arrojadite in 1925.

The same was named to honor of Miguel Arrojado Ribeiro Lisboa (born and died in Rio de Janeiro, 1872-1932). He studied Mining Engineering and Geology at the School of Mines and Metallurgy of Ouro Preto, and was General Inspector of the "Inspetoria de Obras contra as Secas – IOCS", established in 1909, studied the geology of North-Eastern Brazil as well as the geology of Western São Paulo state and Eastern Mato Grosso state and played as important role in the mining industry of Brazil (Figure 27).

Figure 27 – portraits of Miguel Arrojado Ribeiro Lisboa (google.org) and arrojadite (Cornejo; Bartorelli, 2014, Paulo Roberto Amorim dos Santos Lima collection - photo: Marcílio Gazzinelli).

Nine minerals new to science and found in Brazil were described in the 1940s and 1950s: brazilianite, souzalite, frondelite, scorzalite, faheyite, moraesite, barbosalite, tavorite and arsenopalladinite.

Brazilianite ($NaAl_3(PO_4)_2(OH)_4$) was described in 1945 by Pough & Henderson, in alluding to Brazil, where it was first found.

Souzalite ($Mg_3Al_4(PO_4)_4(OH)_6.2H_2O$) was described in 1949 by Pecora & Fahey to honor the mining engineer and director of the "Departamento Nacional de Produção Mineral – DNPM", Dr. Antônio José Alves de Souza (born in 1896, died in 1961).

Frondelite ($Mn^{2+}Fe^{3+}_4(PO_4)_3(OH)_5$) was described in 1949 by Lindberg to honor the American mineralogist Clifford Frondel (born and died in New York, 1907-2002), who was professor of the Harvard University.
Scorzalite ($Fe^{2+},Mg)Al_2(PO_4)_2(OH)_2$) was described in 1949 by Pecora & Fahey, to honor the Brazilian mineralogist and field geologist Evaristo Pena Scorza.

Faheyite ($Be_2Mn^{2+}Fe^{3+}_2(PO_4)_4.6H_2O$) was described in 1953 by Lindberg & Murata, to honor the American mineral chemist Joseph John Fahey (born in Messina, 1901, died in Adelphi, 1980), who worked at the U. S. Geological Survey and described several new minerals, including some of Brazil.

Moraesite ($Be_2PO_4(OH).4H_2O$) was described in 1953 by Lindberg et al., to honor the Brazilian geologist and mineralogist Dr. Luciano Jacques de Moraes (born in "Itabira do Campo", 1896, died in a road of South of Minas Gerais state, 1968), who worked at the Brazilian Geological Survey.

Barbosalite ($Fe^{2+}Fe^{3+}_2(PO_4)_2(OH)_2$) was described in 1955 by Lindberg & Pecora, to honor the Brazilian geologist Aluízio Licínio de Miranda Barbosa (born in Alto Rio Doce, 1916, died in Belo Horizonte, 2013), who was professor of the "Universidade Federal de Ouro Preto", Minas Gerais.

Tavorite ($LiFe^{3+}PO_4(OH,F)$) was described in 1955 by Lindberg & Pecora, to honor the Brazilian geologist Elysiário Távora Filho (born in Jaguaribe, 1911, died in Rio de Janeiro, 2001), who was professor of Universidade do Brasil and director of CNPq ("Conselho Nacional de Pesquisas").

Arsenopalladinite ($Pd_8(As,Sb)_3$) was described in 1955 by Hey, in alluding to its chemical composition (Figures 28-29).

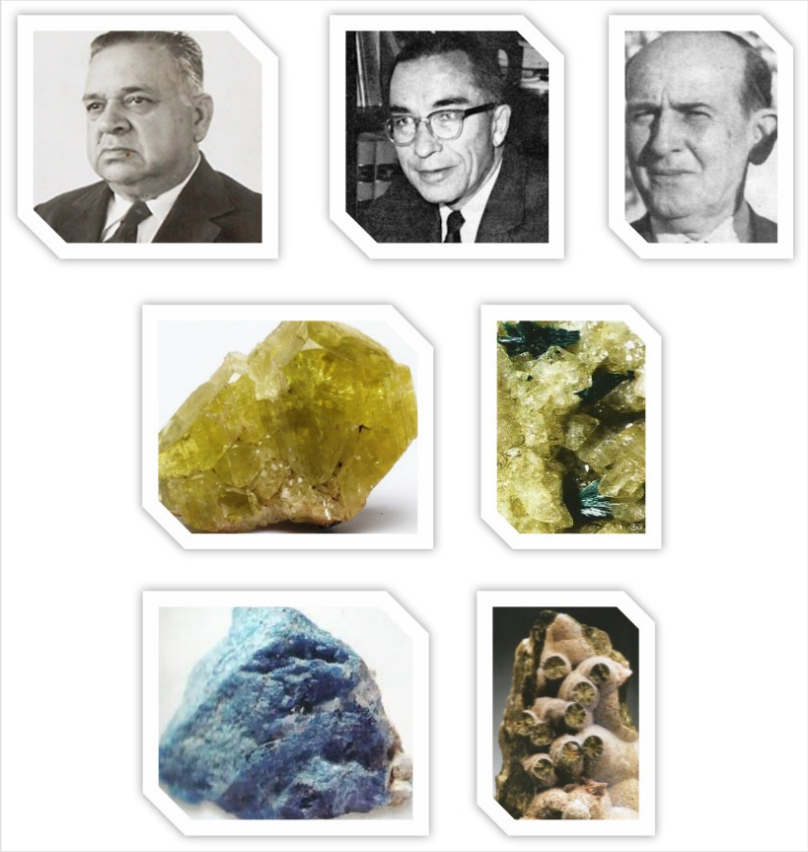

Figure 28 - portraits of Antonio José Alves de Souza (Folha Sertaneja), Clifford Frondel (minsocam.org), Evaristo Pena Scorza (Mindat.org); brazilianite (IGc-USP Museum collection – photo: Thales Trigo), souzalite and scorzalite (Cornejo & Bartorelli, 2014 – Luiz Alberto Dias de Menezes Filho collection - photographies: Marcelo Lerner and Tatiana Menezes) and frondelite (Cornejo & Bartorelli, 2014 – Antônio Carlos Chagas Ramos collection - photo: Marcelo Lerner).

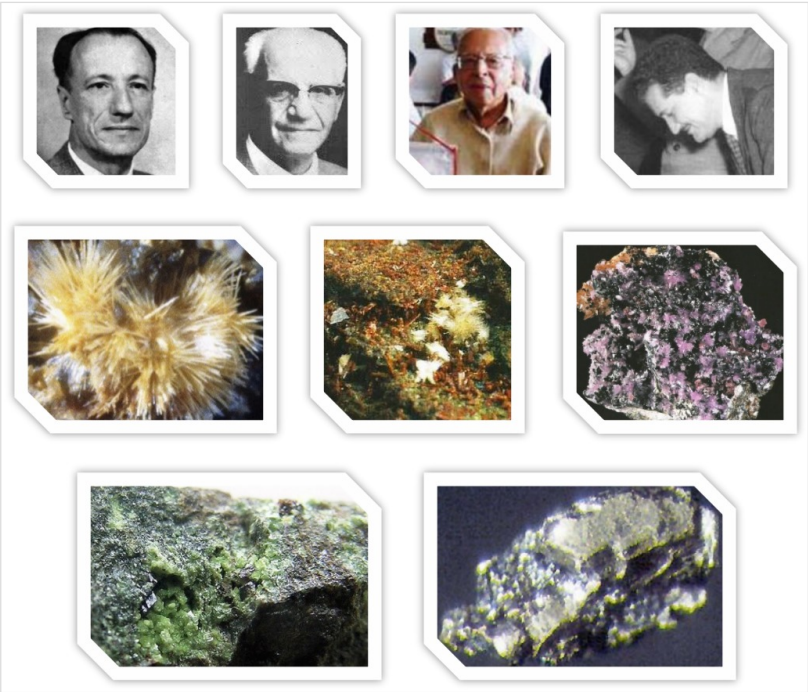

Figura 29 – portraits of Joseph John Fahey (minsocam.org), Luciano Jacques de Moraes (sbg.mg.org.br), Aluízio Licínio de Miranda Barbosa (scielo.br) and Elysiário Távora Filho (Zenith.mast.br); faheyite (Edson Ferreira dos Santos collection & photo), moraesite (white crystals - Cornejo; Bartorelli, 2014 – USP-IGc Museum collection – photo: Thales Trigo), barbosalite (Cornejo; Bartorelli, 2014 – black crystals – Luiz Alberto Dias de Menezes Filho collection - photo: Marcelo Lerner), tavorite (Peter Cristofono collection & photo) and arsenopalladinite (Excalibur Min. Corp. collection – photo: Jeffrey Weissman).

In the years 60s of the 20th century there was a paralysis in pure mineralogical studies in Brazil, since in this decade no type mineral was identified for Brazil.

The name lipscombite was first used for a synthetic material. The mineral lipscombite with Mn, described by Lindberg (1962) in the Sapucaia pegmatite from Galileia, Minas Gerais and considered a type species, appears to be a different species with Mn or Fe3+ predominating over Fe2+ X-ray diffraction patterns are practically identical, but the chemical results are very poor and an adequate formula can not be obtained. The lipscombite from the Otov

pegmatite, near Domazlice, Bohemia, Czech Republic, described by Cech et al. (1961), could be considered as the type for the species.

The name pseudorutile (1966) was introduced without official approval for a mineral that occurs in many places, including Brazil. This name was discredited and eventually officialy revalidated in 1994 for a species from South Australia.

There is a large number of mineral species from Brazil that were introduced without official justification and include tantalaeschynite-(Ce) (1968), ferrohalotrichite (1969), trauirite (1971), ibitiarite (1975), coutinhite (1981), neodymite (1981) hectorite (1991), and several others.
Six minerals new to science and found in Brazil were described in the 1974 and 1978: atheneite, isomertieite, palladseite, bahianite, witheite-(CaFeMg) and witheite-(MnFeMg).

Atheneite (Pd2(As0.75Hg0.25)) and isomertieite (Pd11Sb2As2) were described in 1974 by Clark et al., respectively, in allusion to the Gooddes of Greek mythology Palas Athena and it high contente in Pd and its composition similar to that mertieite and its crystalline system.

Palladseite (Pd17Se15) was described in 1977 by Davis et al., in allusion to its chemical composition based on Pd and Se.

Bahianite (Al5Sb5+3O14(OH)2) was described in 1978 by Moore et al., in reference to the Bahia state, Brazil, from within which the mineral species were found.

Whiteite-(CaFeMg) (CaFe2+Mg2Al2(PO4)4(OH)2.8H2O) and whiteite-(MnFeMg) (Mn2+Fe2+2Mg2Al2(PO4)4(OH)2.8H2O) were described in 1978 by Moore et al. and Moore & Ito respectively, both to honor the geologist John Sampson White Jr. (born in Monessen, 1933) curator of minerals of Smithsonian Institution and founder of the Mineralogical Record Journal (Figure 30).

Figure 30 – portraits of John Sampson White Jr. (Mineralogical Magazine); atheneite (Ath - The Canadian Mineralogist - Bindi, 2010), isomertieite (Klaus Schäfer collection & photo), bahianite (Cornejo; Bartorelli, 2014 - IGc-USP Museum collection – photo: Thales Trigo), palladseite (EDS - Mineralogical Magazine - Cabral et al., 2002 – photo: Rogério Kwitko-Ribeiro), whiteite-(CaFeMg) (Luigi Chiappino collection – photo: L. Chiappino) and whiteite-(MnFeMg) (Stephan Wolfsried collection – photo: S. Wolfsried).

More than ten years later, in the 80s of the 20th century, three other type minerals have been described for Brazil: lanthanite-(Nd), minasgeraisite-(Y) and lanthanite-(Ce).

Lanthanite-(Nd) (Ce,La,Nd)2(CO3)3.8H2O was described in 1980 by Roberts et al., in allusion to its chemical composition containing lanthanide series elements with Nd dominate.

Minasgeraisite-(Y) (BiCa(YLa)2(□Mn)2(Be,B,Si)4Si4O16[(OH),O]4) was described in 1986 by Foord et al., in reference to the Minas Gerais state, Brazil, where the mineral species was found.

Lanthanite-(La) was described in 1987 by Nickel & Mandarino, in allusion to its chemical composition containing lanthanide series elements with La dominate (Figure 31).

Figure 31 –portraits of lantanithe-(Nd) (left) and lantanithe- La (right) (IGcUSP Museum collection – photo: Thales Trigo) and minasgeraisite-(Y) (Cornejo; Bartorelli, 2014 – Luiz Alberto Dias de Menezes Filho collection – photo: Tatiana Menezes).

In the 1990s, four other type minerals were describe for Brazil: zanazziite, arupite, yanomamite and quintinite.

Zanazziite (Ca2(Mg,Fe2+)(Mg,Fe2+Al)4Be4(PO4)6(OH)4.6H2O) was described in 1990, by Leavens et al., to honor the Italian crystallographer and professor of mineralogy Pier Francesco Zanazzi (no disponible photo) (born in Gorizia, 1939) at the Perugia University.

Arupite (Ni3(PO4)2.8H2O) was described in 1990 by Buchwald, to honor the Danish Hans Henning Arup (photo no avaliable) (born in 1928, died in 2012), director of the Danish Corrosion Center, in Copenhagen.

Yanomamite (InAsO4.2H2O), (InAsO4.2H2O), was described in 1994 by Botelho et al., in allusion the Yanomami ethnicity, indigenous people of the Amazon.

Quintinite (Mg4Al2(OH)12CO3.3H2O), was described in 1997 by Chao et al., to honor the Canadian geologist Quintin Wight (born in Ottawa, 1935), researcher in the geology and mineralogy of the Mont-Saint-Hilaire, Quebec (Figure 32).

Figure 32 – portrait of Quintin Wight (landportal.org); zanazziite (Edson Ferreira dos Santos collection & photo), arupite (turquoise-blue - Santa Catharina meteorite – National Museum/RJ – photo: Maria Elizabeth Zucolotto), yanomamite (Luigi Chiappino collection & photo) and quintinite (Cornejo & Bartorelli, 2014 - Luiz Alberto Dias de Menezes Filho collection - photo: Tatiana Menezes).

In 1991, the names osmiridium (1824) and iridosmine (1827) were officially discarted in favor of iridium and osmium, respectively. The same occurred in 1992 with the mineral staringite, until then considered a type mineral of Brazil, was officially discredited by IMA; already in 1994 the minerals ferrazite (1919) and chavesite (1958) were discredited with approval from CNMMN – IMA.

According to Smith Jr. (1995), there are only three compilations about Brazilian minerals (Ferraz, 1928, Froés de Abreu, 1965 and Franco, 1972) and one about minerals from the São Paulo state (Knecht, 1950). None of these has been updated. One can add articles: Oliveira (1930), Leonardos (1955) and Franco (1981). The book of Atencio (2000) represents an updated of the subject (Figure 33).

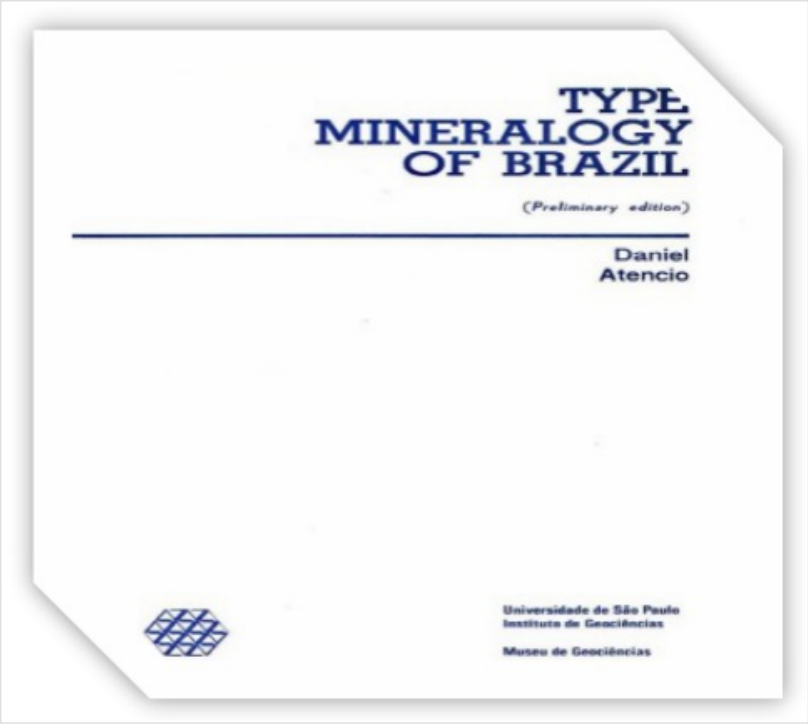

Figure 33 - cover of Type Mineralogy of Brazil (Atencio, 2000).

Between 2000 and 2004, four new type minerals were described for Brazil: serrabrancaite, dukeite, coutinhoite and lindbergite.

Serrabrancaite (MnPO4.H2O) (MnPO4.H2O) was described in 2000 by Witzke et al. in allusion to Serra Branca pegmatite, Pedra Lavrada, Paraíba state, where the mineral was found.

Dukeite (Bi3+24Cr6+8O57(OH)6(H2O)3) which was also described in 2000 by Burns et al.. This mineral was named after Duke University (North Carolina), as the holotype specimen was discovered in its collections.

Coutinhoite (Thx(Ba1-2x)(H2O)y(UO)2Si5O13.H2O) and lindbergite (Mn(C2O4).2H2O) were described by Atencio et al., 2004a,b, respectively. The first to honor the Brazilian petrologist José Moacyr Vianna Coutinho (born in Avaré, 1924), emeritus professor of petrology of the São Paulo University; the second to honor the American mineralogist Marie Louise Lindberg Smith (photo no avaliable) (born in 1918, died in 2005) of the U. S. Geological Survey (Figure 34).

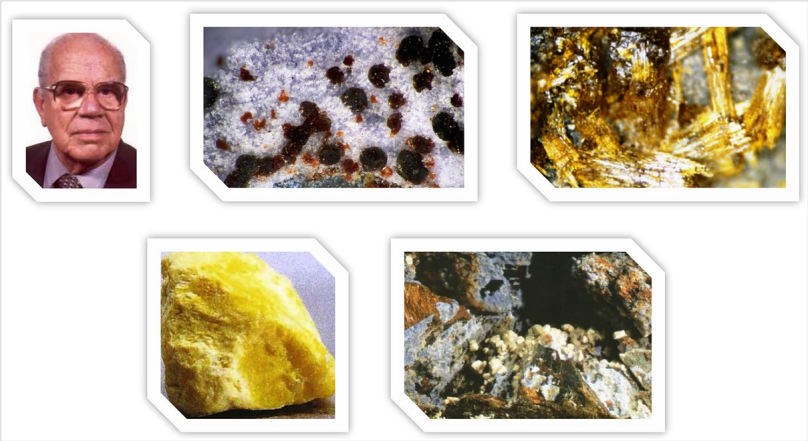

Figure 34 – portraits of José Moacyr Vianna Coutinho (ig.unicamp.br); serrabrancaite (Luigi Chiappino collection – photo: Serge Lavarde), dukeite (Smithsonian Institution Offices collection – photo: J. A. R. Stirling), coutinhoite (Cornejo; Bartorelli, 2014 – IGc-USP Museum collection – photo: Thales Trigo) and lindbergite (Cornejo; Bartorelli, 2014 – Luiz Alberto Dias de Menezes Filho collection – photo: Tatiana Menezes).

In 2003 two new names for Brazilian minerals (waimirite and atroarite) were introduced in the literature (MINUZZI et al., 2003) without the approval of IMA.

Between 2005 and 2006, four new type minerals were described for Brazil: oxykinoshitalite, atencioite, kalungaite and matioliite.

Oxykinoshitalite (Ba(Mg2Ti4+)(Si2Al2)O10O2) was described in 2005 by Kogarko and was found in alkali rocks of the Fernando de Noronha archipelago, Pernambuco state. The name is an allusion to chemical composition and relationship with kinoshitalite.

Atencioite (Ca2(Fe2+)3Mg2Be4(PO4)6(OH)4.6H2O) and kalungaite (PdAsSe) were described in 2006 by Chukanov et al. and Botelho et al. respectively, to honor the Brazilian mineralogist Daniel Atencio (born in São Caetano do Sul, 1959), professor of crystallography of the São Paulo University, the largest discoverer of new mineral species for Brazil and the kalunga ethnic group ("quilombolas") from inner Goiás state (Figure 35).

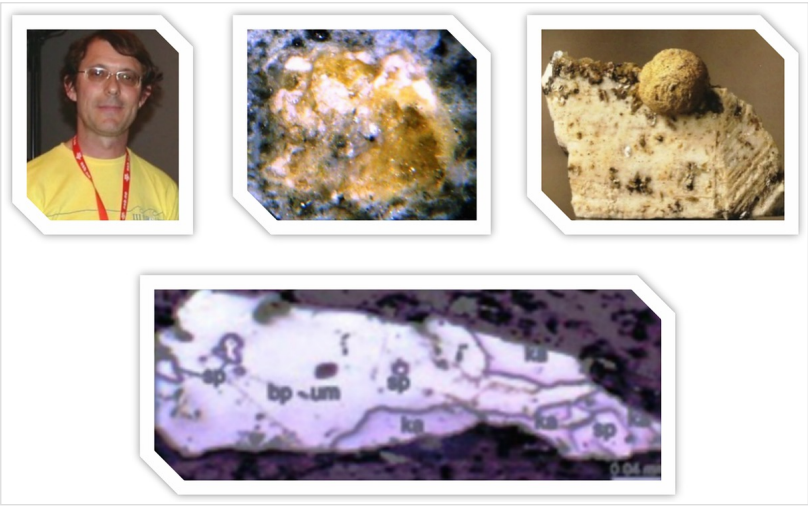

Figure 35 – portrait of Daniel Atencio (inthemine), oxykinoshitalite (Luigi Chiappino collection & photo), atencioite (Luiz Alberto Dias de Menezes Filho collection – photo: Tatiana Menezes), and kalungaite (Ka – reflected light - Mineralogical Magazine - Botelho et al., 2006 - photo: Nilton Francesquini Botelho).

Matioliite (NaMgAl5(PO4)4(OH)6.2H2O) was described also in 2006 by Atencio et al. to honor the Brazilian geographer and mineralogist MSc. Paulo Anselmo Matioli (born in Santos in 1978) (Figure 36).

Figure 36 – portrait of Paulo Anselmo Matioli (jornalusp.br), matioliite (Cornejo; Bartorelli, 2014 – Luiz Alberto Dias de Menezes Filho collection - photography: Tatiana Menezes).

Also in 2006, the minerals giannettite and lewisite were officialy discredited as being identical to hainite and roméite with Ti, respectively (BURKE, 2006). In the same year the Brazilian type mineral arrojadite became a group of minerals (Chopin et al., 2006).

Between 2007 and 2008, others four new type minerals were described for Brazil: guimarãesite, ruifrancoite, menezesite and brumadoite.

Guimarãesite (Ca2(Zn,Mg,Fe)5Be4(PO4)6(OH)4.6H2O) was described in 2007, and in the same year ruifrancoite (Ca2(□,Mn2+)2(Fe3+,Mg,Fe2+,Al4)Be4 (PO4)6(OH)4(OH,H2O)2.4H2O), respectively by Chukanov et al. and Atencio et al.; the first to honor the Brazilian geoscientist Djalma Guimarães, and the second the Brazilian naturalist Rui Ribeiro Franco (born in São José do Rio Pardo, 1916, died in São Paulo, 2008), emeritus professor of mineralogy at the São Paulo University.

Menezesite (Ba2MgZr4(BaNb12O42).12H2O), was described in 2008a by Atencio et al. to honor the mining engineer Luiz Alberto Dias de Menezes Filho (born in São Paulo, 1950, died in Belo Horizonte, 2014), one of the great discoverers of rare minerals of Brazil.

Brumadoite (Cu3(Te6+O4)(OH)4.5H2O), was described also in 2008b by Atencio et al. in allusion to the locality of Brumado, Bahia state, where te mineral was found (Figure 37).

Figure 37 – portraits of Djalma Guimarães (ufmg.br) Rui Ribeiro Franco and Luiz Alberto Dias de Menezes Filho (Cornejo; Bartorelli, 2014 – photographies: Andrea Bartorelli), guimarãesite (Cornejo; Bartorelli, 2014 – Paulo Roberto Amorim dos Santos Lima collection – photo: Marcílio Gazzinelli), ruifrancoite and menezesite, (Cornejo; Bartorelli, 2014 – Luiz Alberto Dias de Menezes Filho collection – photographies: Tatiana Menezes), and brumadoite (IGc-USP Museum collection – photo: Thales Trigo).

Two years after, four other Brazilian type minerals were proposed: bendadaite, manganoeudialyte, qingheiite hydroxycalcioroméite, all in 2010.

Bendadaite (Fe2+Fe3+2(AsO4)2(OH)2.4H2O) by Kolitsch et al., named after the co-type locality, Bendada pegmatite in Portugal. In Brazil it occurs in Almerindo mine, Divino das Laranjeiras, Minas Gerais state.

Hydroxycalcioroméite by Atencio et al. ((CaSb3)2)Sb5+,Ti)2O6(OH)), by Atencio et al., came to be called by this name in agreement with the new nomenclature for the Pyrochlore Supergroup (ATENCIO et al. 2010) and refers to a roméite-group mineral with Ca as the dominant species of the dominant-valence group at the A site, and (OH) as the dominant species of the dominant-valence group at the Y site.

Manganoeudialyte (Na14Ca6Mn3Zr3[Si26O72(OH)2](H2O,Cl,O,OH)6) by Nomura et al., named following the nomenclature of eudialyte group minerals (RASTSVETAEVA & CHUKANOV, 2012).

Ferrogingheiite (NaNa2Fe2+(PO4)3) by Hartet et al., formely called qingheiite-(Fe2+), which was found in Sebastião Cristino pegmatite near the Córrego Frio mine, Linópolis, Divino das Laranjeiras, Minas Gerais state. (Figure 38).

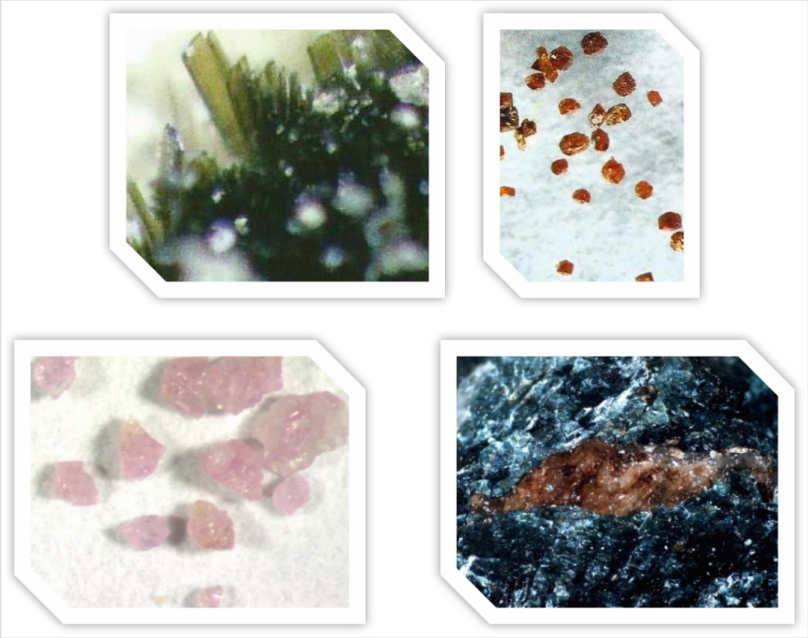

Figure 38 – bendadaite and hydroxycalcioroméite (Cornejo; Bartorelli, 2014 – IGc-USP Museum collection – photographies: Thales Trigo), manganoeudialyte (Daniel Atencio collection & photo) and ferroqingheiite (Luigi Chiappino collection – photo: Germano Fretti).

In 2010 with the approval of IMA a new system of nomenclature was published for the Super Group of Pyrochlore. So, minerals like djalmaite (1939) and rijkeboerite (1963) that were scrutinized. Many other species pertaining to this supergroup are presentely under study (ATENCIO et al., 2010).

Between 2011 and 2013, others six new type minerals were described for Brazil: fluornatromicrolite, jacutingaite, caslosbarbosaite, fluor-elbaite, fluorcalciomicrolite and hydrokenomicrolite.

Fluornatromicrolite ((Na,Ca,Bi)2Ta2O6F), was described in 2011 by Witzke et al., and is named according to the system of nomenclature for the Pyrochlore Supergroup minerals approved by IMA-CNMNC (Atencio et al. 2010). It is characterized by F dominance at the Y site, Na dominance at the A site, Ta dominance at the B site.

Jacutingaite (Pt2HgSe3), was described in 2012 by Vymazalová et al., and is named after the specular-hematite-rich vein-type gold and platinoid mineralizations locally known as “jacutinga”, very common in the mines of the “Quadrilátero Ferrífero”, Minas Gerais state.

Carlosbarbosaite ((UO2)2Nb2O6(OH)2.2H2O) was described in 2012 to honor of the chemical engineer Carlos do Prado Barbosa (born in Alfenas, 1917, died in Rio de Janeiro, 2003) by Atencio et al., who worked on “Instituto Nacional de Tecnologia” of Rio de Janeiro.

Fluor-elbaite (Na(Li1.5Al1.5)Al6(Si6O18)(BO3)3(OH)3F), was described in 2013 by Bosi et al., being it name assigned according to the chemical composition.

Fluorcalciomicrolite ((Ca,Na,□)Ta2O6F) and hydrokenomicrolite ((□H2O)2Ta2(O,OH)6(H2O)) were described in 2013a,b by Andrade et al., is named according to the system of nomenclature for the Pyrochlore Supergroup minerals approved by IMA-CNMNC (ATENCIO et al. 2010). It is characterized by F dominance at the Y site, Ca dominance at the A site, Ta dominance at the B site; hydrokenomicrolite is characterized by H2O dominante at the Y site, □ dominante at the A site, Ta dominante at the B site. (Figure 39).

Figure 39 – portraits of Carlos do Prado Barbosa (Mineralogical Magazine); fluornatromicrolite (IGc-USP Museum collection – photo: Thales Trigo), jacutingaite (gray) (Clausthal Technological University Museum collection – photo: Alexandre Raphael Cabral), carlosbarbosalite (IGc-USP Museum collection – photo: Thales Trigo), fluor-elbaite (Dr. Rob Lavinsky collection & photo), fluorcalciomicrolite and hydrokenomicrolite (IGc-USP Museum collection – photographies: Marcelo Barbosa Andrade).

Between 2014 and 2015 six type minerals were approved by Brazil: césarferreiraite, correianevesite, almeidaite, pauloabibite, waimirite-(Y) and lefontite:

Césarferreiraite ($Fe^{2+}Fe^{3+}_2(AsO_4)_2(OH)_2.8H_2O$) was described in 2014 by Scholz et al., to honor the gemologist César Mendonça Ferreira (born in 1942), professor of the "Universidade Federal de Ouro Preto".

Correianevesite ($Fe^{2+}Mn^{2+}_2(PO_4)_2.3H_2O$) was described in 2014 by Chukanov et al., in honor of the Portuguese mineralogist José Marques Correia Neves (born in Coimbra in 1929, died in Belo Horizonte in 2011), researcher of pegmatites of Minas Gerais and Professor of the "Universidade Federal de Minas Gerais".

Almeidaite ($Pb(Mn,Y)Zn_2(Ti,Fe^{3+})_{18}O_{36}(O,OH)_2$) and pauloabibite $NaNbO_3$, were described in 20125a,b by Menezes Filho et al., the first to honor the Professor Fernando Flávio Marques de Almeida (born in Rio de Janeiro, 1916, died in São Paulo, 2013), graduated in civil engineering, but had his entire professional life devoted to geology, being considered one of the most importante Brazilian geologists; the second to honor the mining and metallurgic engineer Paulo Abib Andery (born in Pouso Alegre, 1922, died in São Paulo, 1976), Professor of the "Universidade de São Paulo", with developed the phosphate processing in Brazil.

Waimirite-(Y) (YF_3), was described in 2015 by Atencio et al., in alusion to Waimiri-Atroari indian people of Amazon.

Lefontite ($Fe_2Al_2Be(PO_4)_2(OH)_6$) was described in 2015 by Yang et al., to honor of the American Mr. Mark Roger LeFont (born in 1955), a meritorious to the Mineralogy Museum of the University of Arizona (photo no avaliable) (Figure 40).

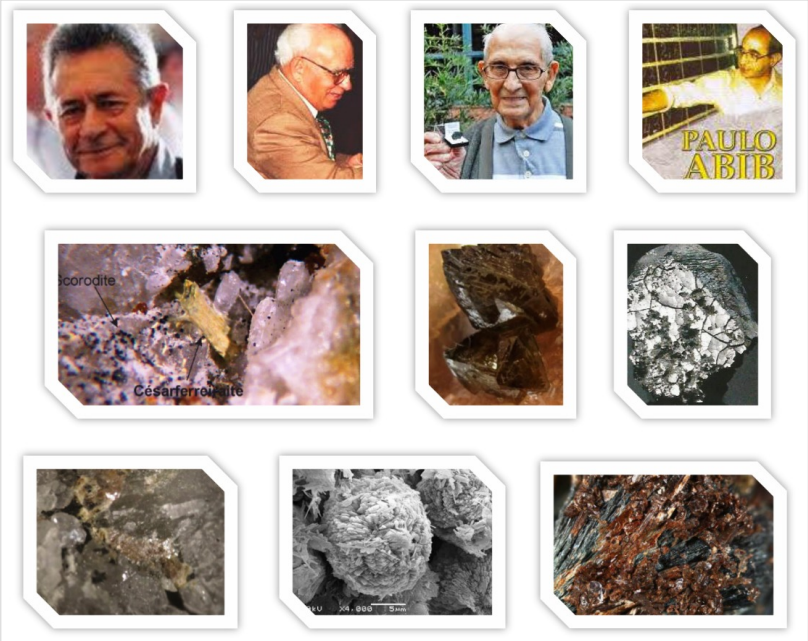

Figure 40 – portraits of César Mendonça Ferreira (lindekin.com), José Marques Correia Neves (abo.com.br), Fernando Flávio Marques de Almeida (Cornejo; Bartorelli, 2014 - photo: Andrea Bartorelli), Paulo Abib Andery (adimb.com.br); césarferreiraite (Ricardo Scholz collection & photo) correianevesite (Edson Ferreira dos Santos collection & photo), almeidaite (Cornejo; Bartorelli, 2014 – Andrea Bartorelli collection – photo: Marcelo Lerner), pauloabibite (IGc-USP Museum collection - Luiz Alberto Dias de Menezes Filho collection – photo: Tatiana Menezes), waimirite-(Y) (BES - IGc-USP Museum collection – photo: Daniel Atencio) and lefontite (RRUFF Project – ID: R140428).

In 2016 only one type mineral was described to Brazil: jeffbenite (Mg3Al2Si3O12), by Nestola et al., 2016, in honor to Scottish scientists Jeffrey W. Harris (born in Glasgow, 1940), from School of Geographical and Earth Sciences, Glasgow University, and Ben Harte (born in 1941), from Edinburgh University (Figure 41).

Figure 41 – portraits of Jeffrey W. Harris and Bem Harte (google.scholar and The University of Edinburgh) and jeffbenite (Mineralogical Magazine - Nestola et al., 2016).

Also in 2016, parabariomicrolite was discredited by Atencio (2016).

In 2017, four new minerals were introduced into the mineralogy of Brazil: wilancookite, brandãoite, hydroxycalciomicrolite and hydroxykenopyrochlore.

Wilancookite ((Ba,K,Na)8(Ba,Li,□)6Be24P24O96.32H2O), was described in 2017 by Hatert et al., 2017, to honor the American geologist William Cook (born and died in Cleveland 1927-2006) and his wife, mathematician Anne Cook (born in Cleveland in 1928), two avid mineral collectors.

Brandãoite (BeAl2(PO4)2(OH)2(H2O) was described in the same year, by Menezes Filho et al., to honor of the Professor Paulo Roberto Gomes Brandão, Department of Mining Engineering of the Federal Minas Gerais University.

Hydroxycalciomicrolite (Ca1.5Ta2O6(OH) was also described this year, by Andrade et al., is named according to the system of nomenclature for the Pyrochlore Supergroup minerals approved by IMA-CNMNC (Atencio et al. 2010). It is characterized by OH dominance at the Y site, Ca dominance at the A site, Ta dominance at the B site, and a P cubic lattice. Also, minor amounts of F cubic lattice crystals are present in the heavy minerals concentrate.

Hydroxykenopyrochlore ((□,Ce,Ba)2(Nb,Ti)2O6(OH,F)), was also described this year, by Miyawaki et al., is named according to the system of nomenclature for the Pyrochlore Supergroup minerals approved by IMA-CNMNC (Atencio et al. 2010). It is characterized by OH dominance at the Y site, □ dominance at the A site, and Nb dominance at the B site (Figure 42).

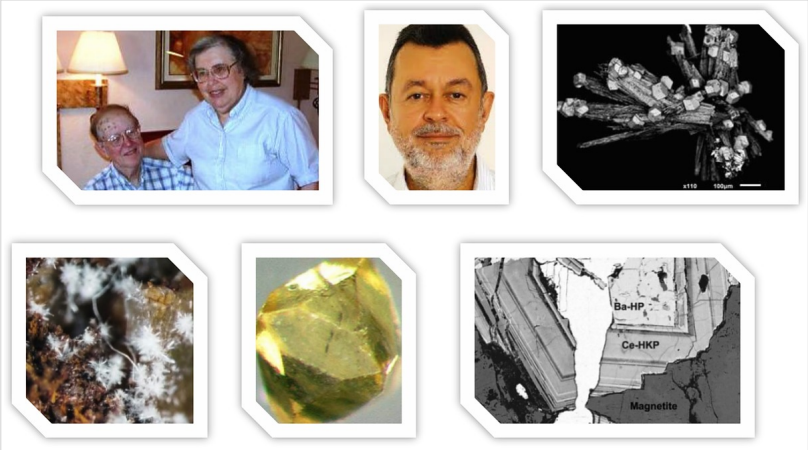

Figure 42 – portraits of Wiliam and Anna Cook (Mindat.org), Paulo Roberto Gomes Brandão (somos.ufmg.br); wilancookite (Federal Ouro Preto University collection – photo: Ricardo Scholz), brandãoite (Museu do IGc-USP collection – photo: Tatiana Menezes) hydroxycalciomicrolite (IGc-USP Museum collection – photo: Marcelo Barbosa Andrade) and hydroxykenopyrochlore (Ce-HKP – BSE – Mineralogical Magazine - Miyawaki et al., 2017).

Finally, eight type minerals were described for Brazil between 2018 and 2020: parisite-(La), fluorlamprophyllite, melcherite, jahnsite-(MnMnMg), jahnsite-(NaMnMg), breyite, ellinaite and oxycalciomicrolite.

Parisite-(La) ($CaLa_2(CO_3)_3F_2$) was described in 2018 by Menezes Filho et al., the name is due to its relationship with parisite-(Ce).

Fluorlamprophyllite ($(Sr,Na)Ti_2Na_3Ti(Si_2O_7)_2O_2F_2$) and melcherite ($BaCa_2MgNb_6O_{19}.6H_2O$) were described in 2018a,b by Andrade et al., the first name is because it is F-dominant with respect to lamprophyllite, which is OH-dominant; the second name to honor the Professor Geraldo Conrado Melcher (born in 1924, died in 2011) (photo no avaliable) of Polytechnic School of the São Paulo University.

Jahnsite-(MnMnMg) ($Mn^{2+}Mn^{2+}Mg_2Fe^{3+}_2(PO_4)_4(OH)_2.8H_2O$) and jahnsite-(NaMnMg) ($(Na,Ca)(Mn^{2+},Fe^{3+}_2(Fe^{3+}_2)(PO_4)_4(OH)_2.8H_2O$) were described also in 2018 respectively by Vignola et al. and Kampt et al., both to honor the American mineralogist Richard Henry Jahns (born in Los Angeles in 1915, died in Palo Alto in 1983), of Stanford University.

Breyite ($Ca_3Si_3O_9$) was described in 2018 by Brenker et al., to honor the German mineralogist Gerhard Peter Brey (born in Vordiplom in 1947), Professor of Goethe University of Frankfurt.

Ellinaite ($CaCr_2O_4$) was described in 2019 by Sharygin et al. (in press), to honor the Russian mineralogist dr. Ella (Ellina) Vladimirovna Sokol, of the Sobolev Institute Russian Academy of Sciences (corresponds to unnamed Ca-Cr-oxide of the "Juína" (Mato Grosso) (Kaminsky et al., 2015).

Oxycalciomicrolite ($Ca_2Ta_2O_6O$), was described also in 2019, by Menezes da Silva et al. (in press), named according to the system of nomenclature for the Pyrochlore Supergroup minerals approved by IMA-CNMNC (Atencio et al. 2010a). It is characterized by O dominance at the Y site, Ca dominance at the A site, Ta dominance at the B site. (Figure 43).

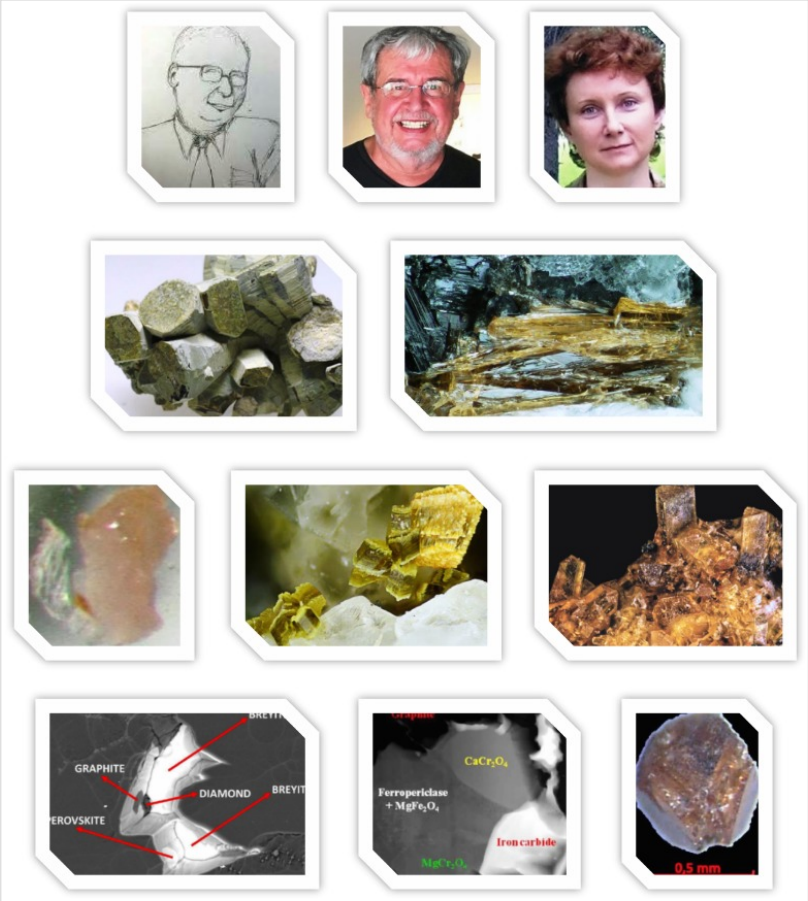

Figure 43 – portraits of Richard Henry Jahns (caricature) (Wikipedia.org), Gerhard Peter Brey (Mindat.org) and Ella (Ellina) Vladimirovna Sokol (Elsevier); parisite-(La) (Menezes Filho et al., 2018 – photo: Tatiana Menezes), fluorlamprophyllite (Mineralogical Magazine - Andrade et al., 2018), melcherite (Marcelo Barbosa Andrade collection & photo), jahnsite-(MnMnMg) (Jhonatan Gomes collection & photo:) and jahnsite-(NaMnMg) (The Canadian Mineralogist - Kampft et al., 2018), breyite (Mineralogical Magazine – Brenker et al., 2018), ellinaite (TEM - CaCr2O4 - The Canadian Mineralogist – Kaminsky et al., 2015) and oxycalciomicrolite (European Journal of Mineralogy - Menezes da Silva et al. (in press)).

An important work denominated "Enciclopédia dos Minerais do Brasil" by P. C. P. das Neves and D. Atencio was lauched in 2013 and the years that follow (NEVES; ATENCIO, 2013 ("Elementos Nativos e Halogenetos"), 2014 (Sulfetos e Sulfossais"), 2015 ("Óxidos e Hidróxidos"), 2016 ("Carbonatos, Sulfatos e Combinações Orgânicas"), 2017 (Fosfatos, Arseniatos e Vanadiatos"), 2018a ("Tectosilicatos"), 2018b (Elementos Nativos e Halogenetos" – 2nd. ed.), 2019 ("Filossilicatos"), and is higly recommended fot these interested in Brazilian Mineralogy (Figure 44). In the following years, the work will be completed with the volumes that will deal with "Inossilicatos", "Ciclossilicatos", "Sorossilicates" and "Nesossilicatos".

Figure 44 – covers of the volumes of "Enciclopedia dos Minerais do Brasil".

Several minerals originally described as new species were later discarted due to misidentifications (chalmersite, chavesite, harttite, staringite, etc...) or because they are varieties of existing minerals (eschwegeite, paredrite, porpezite, ribeirite, etc...).

Some minerals have been renamed due to new systems for naming mineral groups (rijkeboerite, djalmaite, iridosmine and osmiridium). Other mineral names, such as guimarãesite (old definition) and reitingerite, were given to dubious minerals, whithout adequate justification, and therefore do not have a respectable position in mineralogy. The name tantalaeschynite-(Ce) was wrongly given to tantalaeschynite-(Y), for example. There are also several minerals

with incomplete description that require further studies to establisch them as independente species (joséite-B, oliveiraite, orvillite, pennaite, among others). Type-locality problems also exist: the standard occurrence of lanthanite-(La) was Bastnäs, Sweden, but all lanthanite-(La) were recorded only in Brazil (Curitiba, Paraná state and Santa Isabel, São Paulo state) and the locality-type is currently acepted as Curitiba, Paraná state.

Unfortunately, most of the documents pertaining to these minerals were published in quite inaccesible sources (for example: camposite, coutinhite, gonzagaite, lavrite, neodymite and paulistanite. In addition, several holotypes have not been preserved (bariomicrolite, chrysoberyl, euclase, lipscombite, giannettite, pennaite, gorceixite, palladium, among others).

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Keith Compton - Manager 30th Oct 2020 23:03 UTC

Hi Paulo

Great article

I was not aware that the Filossilicatos had been published. I haven't been able to find anywhere that I can obtain one - any idea where it can be obtained?

I have the other six that have been published.

Kevin Conroy - Manager 31st Oct 2020 00:20 UTC

https://www.editoraulbra.com.br/catalogo/produto/320/ENCICLOPEDIA-DOS-MINERAIS-DO-BRASIL-VOLUME-7-FILOSSILICATOS

Keith Compton - Manager 31st Oct 2020 23:23 UTC

Kevin
Thanks
I have already tried them but no response

Rui Nunes - Expert 30th Oct 2020 23:22 UTC

Great article Paulo et al. Well done!
Um forte abraço deste lado do mar...

Erik Vercammen - Expert 31st Oct 2020 19:21 UTC

In 2016 only one type mineral was described to Brazil: jeffbenite (Mg3Al2Si2O12), by Nestola et al., 2016, in honor to Scottish scientists Jeffrey W. Harris (born in Glasgow, 1940), from School of Geographical and Earth Sciences, Glasgow University, and Ben Harte (born in 1941), from Edinburgh University

A typo: Si2 should be Si3

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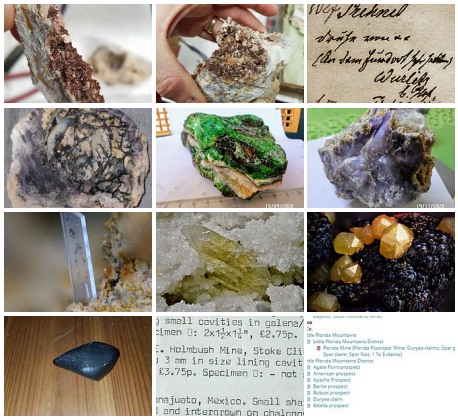

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