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AN OVERVIEW ON THE MINERALOGY AND CRISTALLOGRAPHY FIELD COURSE GUIDE AT THE SERIDÓ PEGMATITIC PROVINCE: A CONTRIBUTION FOR UNDERGRADUATE GEOLOGY STUDENTS OF THE FEDERAL UNIVERSITY OF PERNAMBUCO, BRAZIL

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Abstract

This report presents basic guidelines to help undergraduate first year geology students at the Federal University of Pernambuco Brazil. It reviews general aspects of the Mineralogy field trip presenting a comprehensive review on pegmatite classification, regional geology of the Seridó Pegmatitic Province (Rio Grande do Norte and Paraíba states) as well as local geological aspects of three mines that are visited and locally mapped. During the field trip, the Dedego, Pendanga and Sítio Mulungu mines are visited, offering the opportunity to describe pegmatites and host rocks in one of the most famous regions that produce industrial minerals and gemstones for commercial purposes. During the visit, crystallographic and physical aspects of granitic pegmatite-related minerals are discussed, including didactical varieties of quartz, feldspars, mica, tourmaline, garnet and beryl crystals. Mining aspects on pegmatitic rocks in the region are also accessed, allowing the first-year student to have an early contact with mineral exploration and mining companies and their professionals, which will be of great importance for their development during the geology undergraduate course.

Keywords: Mineralogy, Didactical Field Trip, Federal University of Pernambuco.

1. Introduction

Mineralogy and Crystallography (Mineralogia Sistemática e Cristalografia, in Portuguese) is a mandatory subject of the Geology undergraduate course at the Federal University of Pernambuco, Brazil. It comprises a considerable number of practical exercises, including a field trip that lasts between three to five days depending on the weather conditions, budget availability and logistics. During this activity, the undergraduate student come into contact for the very first time with the fascinating world of minerals, allowing the recognition of the most common but yet, diversified varieties presented in pegmatitic rocks that crop out in the geographic region of the Seridó (Paraíba and Rio Grande do Norte states), in northeastern Brazil.

During the field trip, we describe previously selected didactical outcrops that comprise a variety of rock types, such as the well-known pegmatitic occurrences and their host rocks, from the Seridó Pegmatitic Province, also known as Borborema Pegmatitic Province. In addition, its main scope concerns on the visiting of open pit mines that extract a variable volume of industrial minerals, which are mostly related to pegmatites. Large and modern underground mines may be also visited, allowing the students to enjoy all aspects of a day-by-day routine of a large company, fulfilling gaps that are inherent to the theoretical part of the Mineralogy course.

In this report, our aim is to introduce several aspects of the mentioned field trip, including a general description of the regional geological, basic descriptions of rock types and pegmatite-related minerals for didactical purposes. The guide shall be consulted by undergraduate geology and mining engineering students as an introduction for what will be presented during the mineralogy field trip. A final quiz is also presented at the end of this document.

1.1. Theoretical fundamentation – pegmatites and pegmatites

The term "pegmatite" was originally used by the mineralogist Hafly back in early 1800´s to describe shallow crustal rocks with repeated stages of geometric overgrowths, such as those developed between quartz and feldspar (generally microcline), named graphic intergrowth. Modern descriptions synthetized pegmatites as *"very coarse-grained holocrystalline rocks, containing similar mineralogy to the common silicatic magmatic lithotypes, also presenting unique primary textures intergrowths"* (London, 2008). They are normally formed at the final stages of the SiO_2-rich magma crystallization, normally involving a large volume of volatiles (F^-, OH^-, CO_2).

Pegmatites are highly attractive for the mineral commodity industry, mainly because during its formation, they may concentrate anomalous amounts of uncommon chemical elements such as Nb, Ta, Be, Li, Sn, Zr due to its exotic mineralogy. Common economic-related minerals in granitic pegmatites include spodumene [$LiAl(SiO_3)_2$], petalite ($LiAlSi_4O_{10}$), tantalite-columbite [$(Ta,Nb)_2O_6$], amblygonite [$(Li,Na)AlPO_4(F,OH)$], pollucite [$(Cs,Na)_2Al_2Si_4O_{12}\,2H_2O$] and other U, Th and REE (rare earth elements)-bearing minerals. They also represent sources of the most famous gemstones worldwide, including beryl and its varieties, topaz, tourmaline, chrysoberyl and kunzite. During the field work we will visit several quartz, micas and potassic feldspar mines that have been exploited for decades commonly used for ceramics, insulating purposes and glass industry.

The different geological geometries of pegmatitic bodies greatly vary depending on the depth and emplacement temperature, as well as their relationships with the wall/host rocks, normally in low- to medium grade metamorphic conditions. Under deeper and ductile crustal levels, where high temperature and pressure gradients dominate, the plasticity of the rocks allows the development of curved to elliptical shapes, whilst in shallower crustal levels, brittle deformation dominate, and the main occurrences are restricted to dikes and veins normally related to large-scale fracturing and breccia formations (London, 2008).

Several classification schemes have been used to describe the variations on the pegmatite types, including mineralogical, structural and chemical aspects. Such proposals are very often influenced by emplacement depth criteria as summarized by Ginsburg et al. (1979). These authors distinguished four geological classes:

1) Abyssal type (below 11 km): in this case, the pegmatites present a close relationship with migmatitic segregations and leucosomes submitted to amphibolite and granulite facies rocks. The paragenesis is largely restricted to minerals rich in high-field strength elements (*e.g.*, U, Th, Y, REE, Nb, Zr) as well as Be and B but without economic interest.

2) Muscovite and muscovite-REE types (7-11 km-depth): they include variable mica- and other ceramic-related minerals, being formed at medium pressure and low temperature conditions, and are usually rich in Ca, Ba, Sr, Fe, Mn, REE, Li, Be, Nb, being a common variety at the Seridó Pegmatitic Province.

3) REE-bearing type (3-7 km-depth): these are usually related to common granitic plutons that experienced variable degrees of differentiation in low pressure and temperature conditions, being common sources for lithophile elements and REE. They can be identified according to the characteristic mineralogical paragenesis of beryl, albite and spodumene.

4) Miarolitic type (1.5 – 3.5 km-depth): This class of pegmatitic rocks are formed at epizonal crustal levels, generally presenting high amounts of REE-bearing minerals, also presenting anomalous concentrations of Li, Be, F, B, Ti, Zr, Nb.

The classification proposed by Černý, 1991 is also commonly discussed during our field work. It is based on geochemical, mineralogical and paragenetic criteria, dividing the pegmatites in NYF, LCT and mixed types. These endmembers are defined on the bases of the main distinguished chemical constituents using the following acronyms: N-Niobium, Y- Yttrium and F-Fluorine, L-Lithium, C-Cesium and T-Tantalum. Another well accepted classification was proposed by Heinrich (1948), which is more useful for field descriptions due to the simplistic aspects, once that it is based on the presence or absence of structural units, defining the simple, zoned and complex pegmatite types.

During the 1950-1980´s interval, the proposed scheme by Johnston Jr (1945) were very useful for the Seridó region, mainly because it uses the mineral distribution of common specimens, defining two main types: a) homogeneous and b) heterogeneous. Homogeneous pegmatites are composed of quartz, feldspar and mica as essential phases that are regularly distributed throughout the rock intrusion (Figure 1a). They present tabular forms with a mineral grain size ranging from centimeters to decimeters. In general, homogeneous pegmatites are usually extracted in the block form for the ornamental rocks. On the other hand, heterogeneous pegmatites are characterized by a greater mineralogical variety and have lenticular, rounded-shaped or flat disc shapes. They can be easily distinguished from the homogeneous members due to the presence of a voluminous rounded- to subrounded quartz-core. There are also the mixed pegmatites, which have intermediate characteristics with respect to the homogeneous and heterogeneous ones, besides the presence of two or more cores of massive quartz, also presenting disseminated mica varieties such as phengite, zinnwaldite and lepidolite.

Pressure-temperature dependent classifications (Figure 1b) are generally based on the Černý´s (1991) study of metamorphic conditions for granitic pegmatites, defining five-class depth-zones as seen in Černý and Ercit (2005). General aspects of pegmatite classifications currently known are presented in Table 1.

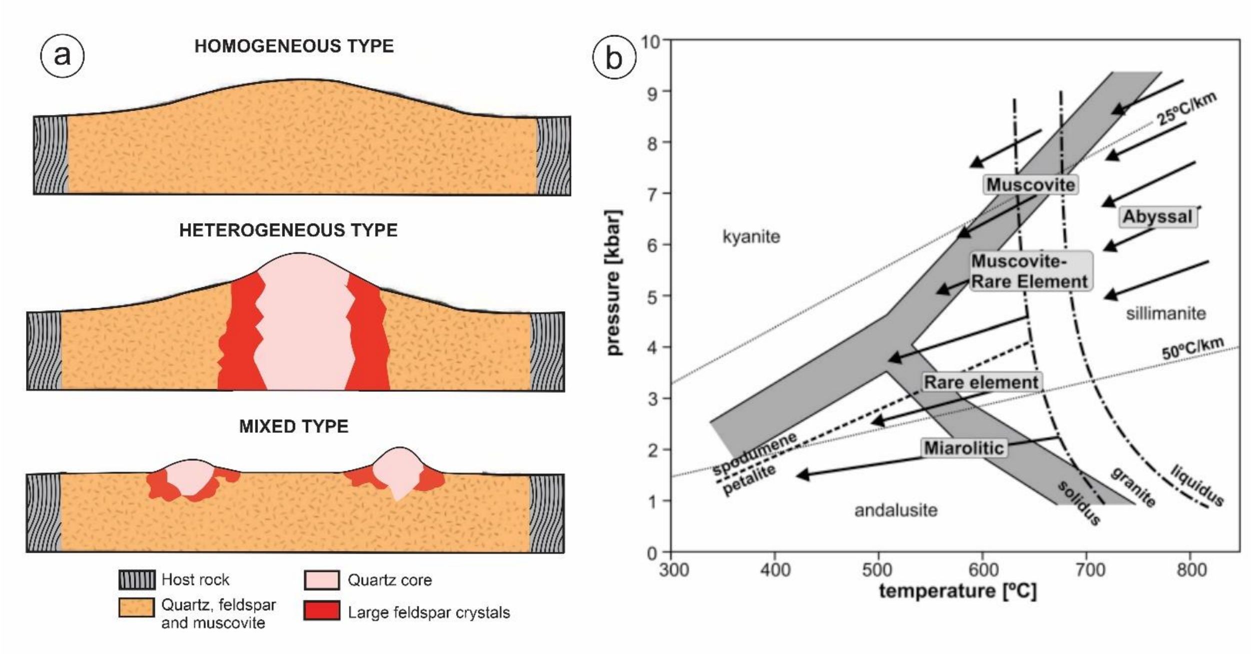


Figure 1: a) Geometry of the proposed pegmatite types by Jonhston Jr. (1945); b) Pressure-temperature diagram for granitic pegmatite formation according to Černý (1991).

Table 1: Most of existing granitic pegmatite classifications, extracted from Müller et al. (2022).

Author	1ª Order classification criterion	2ª Order classification criterion	3ª Order classification criterion	Evaluation
Niggli (1920)	Geochemistry	Mineralogy	-	Not wet constrained
Fersman (1930)	Temperature	Geochemistry	Mineralogy	Temperature alone not sufficient
Landes (1933)	Geochemistry	Mineralogy	Mineralogy	Too simple, not well constrained
Bjorlykke (1937)	Geochemistry	Mineralogy	Mineralogy	Limeted to rare metal pegmatites of NYF family
Vlasov (1952, 1961)	Structure/mineralogy	Mineralogy	-	Too simple, not well constrained
Ginsburg & Rodionov	Emplacement depth	Structure (presence/absence of miarolitic cavities)	Geochemistry	It presupposes that the netamorphic grade of the well rock corresponds to

(1960), Ginsburg (1984)				the P-T conditions at the time of pegmatite emplacement
Schneiderhohn (1961)	Genetic (anatectic vs. magmatic)	Geochemistry	Geochemistry	Too simple: subdivision
Černý (1991a) and (Černý & Ercit (20050	Mixture: emplacement depth, structure and mineralogy	Geochemistry	Mineralogy	lixture of different types of classification criteria in 1st order
Wise (1999)	Mineralogy	Mineralogy	Mineralogy	Classification of NYF-type pegmatites only
Pezzotta (2001)	Mixture: emplacement depth, structure and mineralogy	Mineralogy/geochemi stry	Mineralogy	Limited of pegmatites occurring in Madagascar
Zagarsky *et al.* (1999, 2003)	Emplacement depth	Mineralogy (structure)	ineralogy (structure)	Emplacement depth commonly uncertain
Dill (2016)	Mixture: deformation style, deformation, host rock type and chemical and mineralogical features	Structure	Chemistry	The diction of different egmatite types (1st order) is difficult to draw in several cases

2. Geological setting

The Seridó (or Borborema) Pegmatitic Province is located in the states of Paraiba and Rio Grande do Norte, in an area limited by the 7° and 5° south parallels and 36° and 37°30' west meridians (Figure 2). This region is part of the Borborema Plateau that geographically marks a heterogeneously distributed topography at eastern Brazil. This province was earlier studied by Scorza (1944), becoming later famous in the mineral exploration industry due to the commodity needs as an important supplier of mica as well as Nb, Ta, Be and Li-bearing minerals for the entente triple and the allies, respectively.

These rocks are spatially distributed over an area of approximately 75 km x 150 km mainly hosted by supracrustal rocks of the Seridó Fold Belt, one of the Neoproterozoic units of the Borborema Province (see Caxito et al., 2020; Neves 2021, and Santos et al., 2021, 2022 for recent reviews). The most accepted belt stratigraphy consists, from the bottom to the top, of the Jucurutu, Equador and Seridó formations (*e.g.*, Van Schumus et al., 2003), but others interpret the Equador Fm.as the base of the sequence (Hollanda et al., 2015). A local basement inlier named São Vicente divides it in two sub-belts: Currais Novos and Jucurutu. In addition, most of the belt lithotypes including part of the pegmatites are cross-cut or bounded by N-S strike-slip shear zones.

More than 750 mineralized granitic pegmatites have been identified in this region and, statistically, about 80% are intruded in the sillimanite-garnet-cordierite-biotite-quartz schists of the

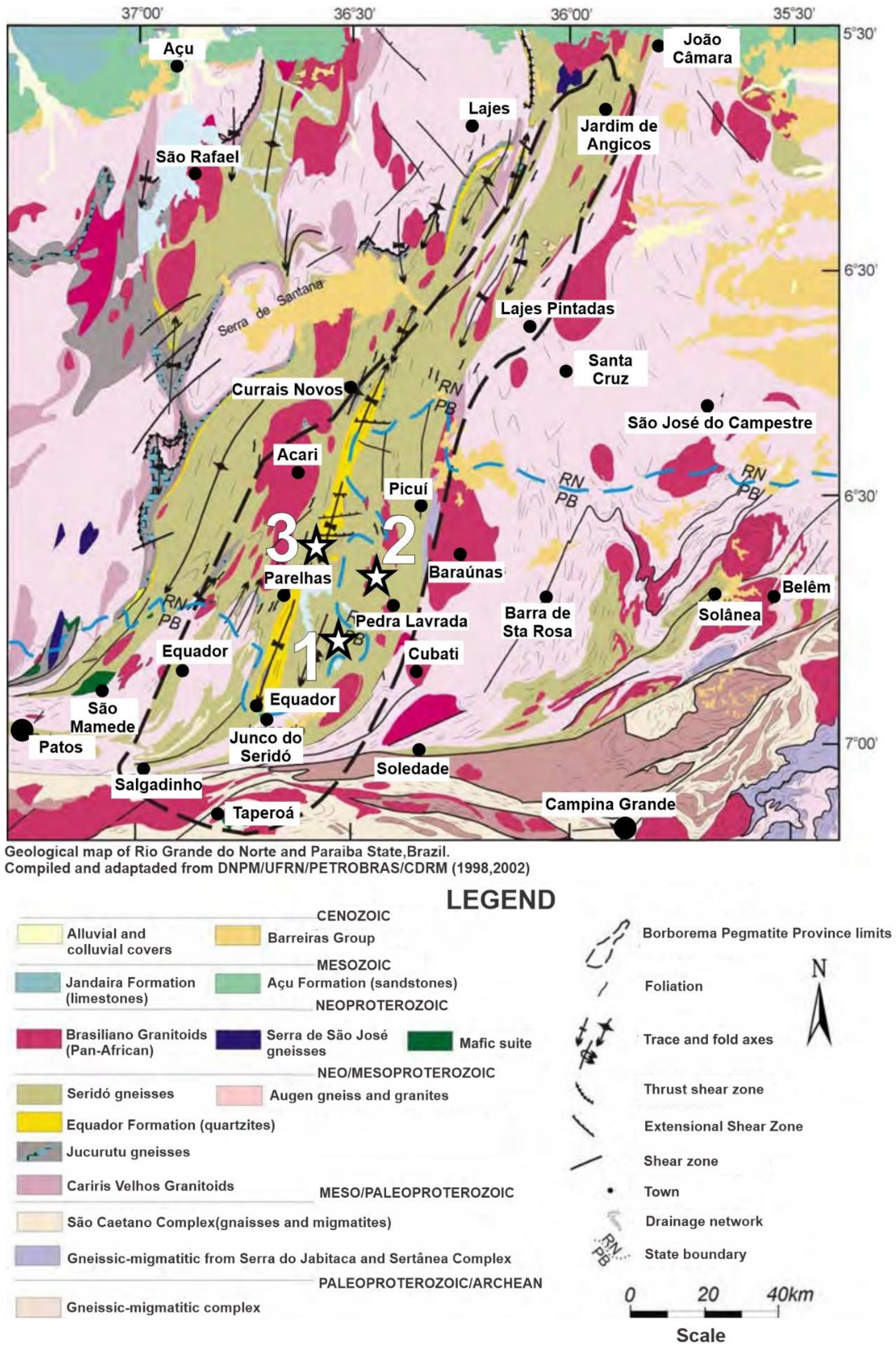


Figure 2: Geological map of the Seridó Pegmatitic Province from Brasil (1998, 2002), Beurlen et al. (2011) and Santos et al. (2014). 1, 2 and 3 stands for the visited mines/sites.

Seridó Formation. Several local names have been given to describe the pegmatitic rocks, mostly emphasizing their elevated topography, including the "high" (alto in Portuguese) adjective, such as Alto dos Mamões, Alto do Feio, Alto da Serra Branca, Alto do Patrimônio, Alto dos Quintos, among others. This geomorphology can be explained by the physical weather resistance of the quartz nuclei in heterogeneous and mixed pegmatites. Meso- and microscopic aspects of each pegmatitic body are synthesized by Beurlen et al. (2009).

3. Field logistics and recommendations

The field trip comprises a well-defined itinerary. All the visited mines are located near the state roads that crosscut the main cities in the region, i.e., Pedra Lavrada and Picuí (Paraíba state). Caution must be taken due to the sunny weather typical of this area of NE Brazil. In addition, it is highly recommended a kind presentation and strict respect when dealing with the local citizens, which are commonly kind and gentle. In all nights we sleep at the Picuí downtown hotels that commonly offer good quality dorms with fair prices considering the local logistics.

4. Outcrops

4.1. Dedego Mine (Site 1)

The first visited outcrop is located at the Dedego mine, which is part of the Alto do Patrimônio Pegmatite (geographical coordinates 6°47'06.1"S 36°31'20.1"W). During the visit, we walk approximately 5 km going up a small and irregular hill in a region known as "Sítio Tibiri" (Figure 3a). The Dedego mine is located 4 km SW of the Pedra Lavrada town and is currently operating on the open pit system (Figure 3b).

This pegmatite body has been well-known since the 1940´s due to a number of exotic minerals that resulted from the interaction between the progenitor magma, host rocks and hydrothermal fluids (*e.g.*, Rolf, 1944). Among them, the cropping out pegmatites host the unique occurrence of brazilianite $[NaAl_3(PO_4)_2(OH)_4]$ phosphate in NE Brazil, which is commonly associated with eosphorite $[Mn^{2+}Al(PO_4)(OH)_2.H_2O]$, hureaulite $[(Mn^{2+})_5 (PO_4)2(PO_3OH)_2.4H_2O]$, wardite $[NaAl_3(PO_4)_2(OH)_4.2H_2O]$, lithiophilite $[LiMn^{2+}(PO_4)]$, crandallite $[CaAl_3(PO_4)_2(OH)_5.H_2O]$, phosphosiderite $[Fe(PO)_4.2H_2O]$, stewartite $[(Mn^{2+},Fe^{3+})2(PO_4)_2(OH)_2.8(H2O)]$, heterosite $[Fe^{3+}(PO_4)]$, sicklerite $[Li (Mn^{2+}Fe^{3+})(PO_4)]$ and well as a number of varieties of the apatite group $[Ca_5(PO_4)_3 (Cl,OH,F)]$. Although the available literature data are restricted and mostly focused on X-ray diffraction and petrographic data (*e.g.*, Murdoch, 1955), local geological maps suggest that this pegmatite present a lenticular to subrounded geometry, that in addition to the presence of a large quartz core, always with well-developed schorl and dravite crystals suggest a heterogeneous origin as postulated by Johnston Jr. (1945).

In this mine, the students can identify clear contacts between garnet-biotite schists of the Seridó Formation with the pegmatite intrusions (Figure 3c) as well as minor gneissic rocks. During the sketching of oriented pegmatite profiles, which is almost NE-SW, easily recognized characteristic minerals of granitic pegmatites can be found and collected in large blocks or in-situ pegmatite slices. Widespread mineral paragenesis include prismatic and granular milky quartz, potassic feldspar (Figure 3d) exhibiting exsolution textures such as perthite as well as the typical Carlsbad twining and minor locally observed periclines. Plagioclase is also widespread but randomly distributed along the pegmatitic body and on larger crystals, is possible to identify polysynthetic twining in mesoscopic scale.

Another interesting aspect is the opportunity to identified large tourmaline crystals with different habits, specially schorl and dravite prisms (Figure 3e), which are encrusted in a quartz-albite groundmass including the pegmatite core and exhibit well developed trigonal and di-trigonal crystal habits with well-developed stretched marks parallel to the C axis. Light purple lepidolite might be found as lamellae aggregate within the quartz core. However, much of this material has been removed during Li-bearing mineral prospecting works. Phosphate occurs as tiny yellow aggregates that can only be classified with chemical and crystallographic analysis through X-ray diffraction. For instance, brazilianite in this pegmatite is highly heterogeneous, complex and randomly distributed, often presenting vertical prisms {110} as well a combination of {101}, {010}, {320}, {130}, {111}, {121}, {311} prisms and basal pinacoids.

4.2. Pendanga Mine (Site 2)

The Pendanga mine is part of the Alto da Pendanga pegmatite, which is located at the NW direction of the Pedra Lavrada town (geographical coordinates 6°42'02.1"S 36°30'21.4"W). This pegmatite has been famous for decades due to the extraction of columbite and tantalite to produce Nb- and Ta-bearing alloys for the steel industry, including specific components for aircrafts and rockets during the cold war space race. The main pathway for the mine can be made by car but covers a non-pavemented irregular road. The geological profiles can be made by foot, once that the mine location can be considered safe, and the terrain is relatively flat. Nowadays this pegmatite is exploited in a low-mechanized open pit and underground mining structure, also including simple extraction by local miners.

This pegmatite is relatively heterogenous in its mineralogical composition, presenting large prismatic to massif milky and pink quartz as well as potassic feldspar with variable twining growths such as Carlsbad, Manebach and Baveno. Abrupt contacts between mylonitized biotite schists and the pegmatite veins are always present, which is typical at the contact zones (Figure 4a). Undifferentiated garnet group minerals occur as disseminated euhedral crystals throughout the pegmatitic body, ranging both in size and crystallography (Figure 4b,c), including combined crystalline forms that can be observed throughout all the geological profiles and might include rhombic dodecahedron {110}, trapezohedron {hhl}, pyritohedron{h0l} positive, {0kl} negative and diploid {hkl}.

These minerals occur incrusted in the quartz-feldspar groundmass that is characterized by widespread graphic texture that are interleaved with large sized well-developed beryl varieties (Figure 4d, 4e), including aquamarine, morganite and goshenite and tourmaline prisms (mostly schorl). Hexagonal and dihexagonal beryl prisms (mostly 6/m 2/m 2/m) reaching up to 30-cm long and is often incrusted by radial muscovite crystal aggregates, including radiate starlike forms, known as “stellated” crystal habit, also occurring as random mica slats along with biotite and secondary chlorite lamellae. In this pegmatite, albite is extracted and late commercialized for the local ceramic industry, mainly because its unique whitish variety known as cleavelandite. In this pegmatite, such mineral specimens are characterized by well-developed polysynthetic twining on the {010} direction, which can be easily seen in the mesoscopic scale.

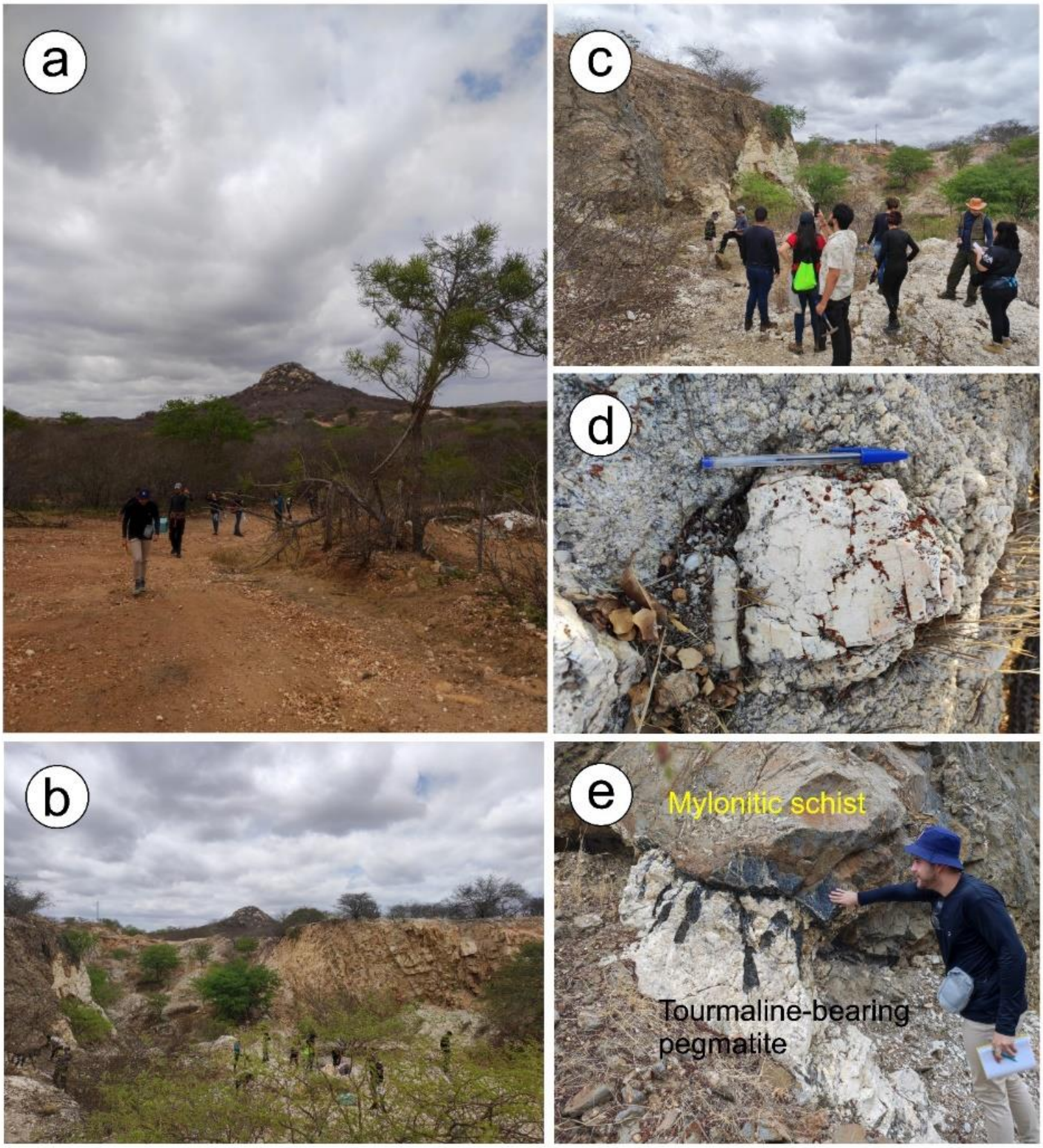


Figure 3: Common geological aspects observed on the Dedego mine: a) Trail Road that leads to the mine region; b) Overview of the open pit developed within the quartz core area; c) Abrupt contact between granitic pegmatite dyke and host garnet-biotite schist of the Seridó formation; d) Large subhedral potassic feldspar crystal; e) Regularly distributed schorl prisms near a geological contact between a pegmatite dyke and host mylonitized schist.

4.3. Sitío Mulungu pegmatite mine (Site 3)

The Sítio Mulungu pegmatite, also known as Alto da/do Capoeira or Boqueirãozinho is located at the vicinities of the Parelhas town (~6 km northeast) at the Rio Grande do Norte state. It is largely famous due to the occurrence of the electric blue variety of tourmaline, known in the gem market as “Paraíba tourmaline”. During the early 1990´s, cuprian pegmatites in the region were discovered via exploration of colluvial deposits, suggesting mineralogical similarities between this region and the pegmatites located at the José da Batalha town, Paraíba. This variety has been explored in this region as well as in correlated pegmatites in Nigeria and Mozambique in Africa. During this manuscript preparation, the Brazil Paraíba Mine was the responsible company to explore and sell Paraíba toumaline crystals in the Sítio Mulungu mine, especially for the Asiatic jewelry industry.

During this visit, several regional aspects of the host pegmatites of the Seridó Pegmatitic Province are discussed as well as the geomorphological aspects of the region, including an overview of the Morro Alto, Serra do Frade and Serra das Queimadas hills, discussing the contrasts between the pegmatite-related and host supracrustal rocks terrains along the “Jucuri line”. The pegmatitic bodies in the region are roughly parallel following an approximately 60º strike direction. During the visit to the Sítio Mulungu region, we cross-cut distinct geological profiles by foot along the mentioned mountain ranges and, if possible, the geology student will visit the underground mine and galleries (Figure 5a), allowing the first contact with step-by-step procedures of a large mining company. This pegmatite is hosted by quartzites and metaconglomerates (Figure 5b,c), being zoned and strongly fractured. The main minerals visible in mesoscopic scale include K-feldspar, plagioclase, muscovite, epidote and a variety of quartz crystals. Accessory minerals include tourmaline (elbaite and schorl) that is widespread and disseminated (Figure 5d) throughout the entire pegmatite, apatite and undistinguished phosphates. Pegmatitic rocks might occur as veins and dykes presenting lobate and abrupt contacts with the host rocks. Pure Paraíba tourmaline is extremely difficult to be identified in hand specimens, but several elbaite crystals presenting regular and irregular intergrowths might be seem during the visit (Figure 5e).

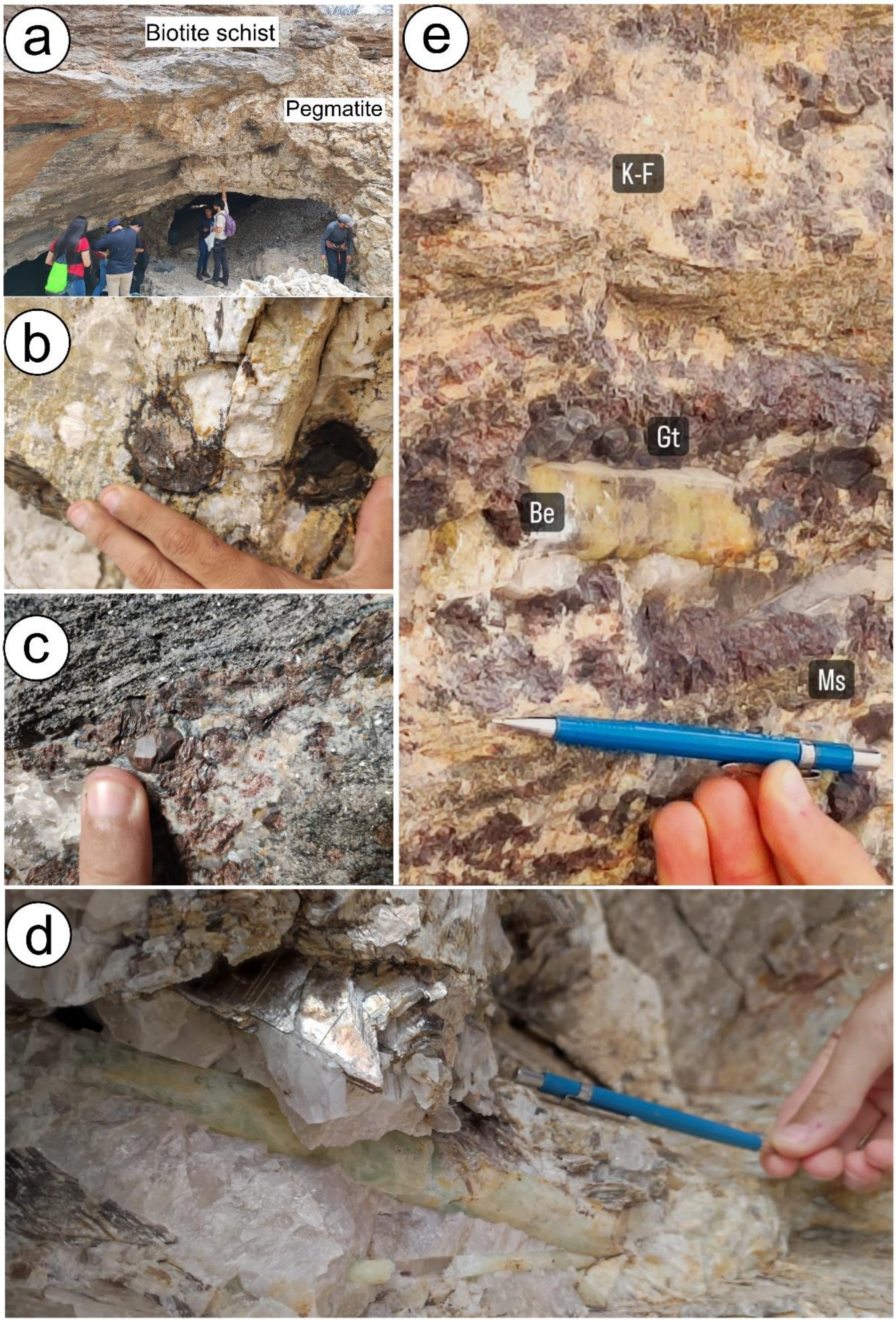


Figure 4: Common geological aspects observed on the Pendanga mine: a) Geologic contact between biotite schist and the pegmatite intrusion; b) Large garnet dodecahedron incrusted in a quartz-feldspar-rich groundmass; c) garnet trapezohedron crystals aggregate; d) stellated muscovite crystals in contact with hexagonal beryl prism; e) mineral assemblage systematically observed on the pegmatite wall near the contact with the host rocks. K-F = potassic feldspar, Gt = garnet, Be = beryl, Ms = muscovite.

Figure 5: Common geological aspects observed on the Sitío Mulungu pegmatite mine. a) Overview of one of the galleries of the underground mine; b) metaconglomerate of the Seridó formation; c) geologic contact between metaconglomerate and the pegmatite intrusion; d) tourmaline vein; tourmaline is also disseminated throughout the entire pegmatite; e) large elbaite trigonal prism presenting regular and irregular intergrowths.

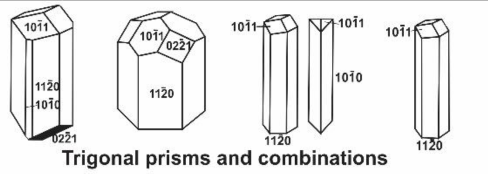
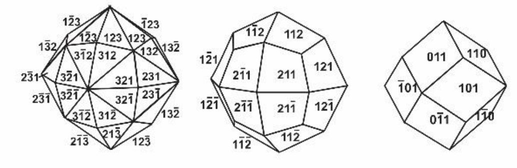
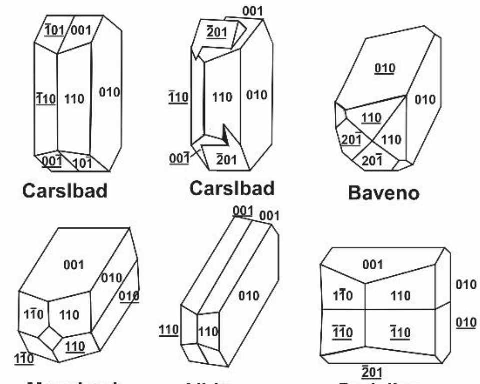
	Crystal habits or twining	Physical diagnostic properties	Common varieties
Tourmaline	 Trigonal prisms and combinations	**Color:** black is most common color. Also occurs in blue, green, yellow, red, and colorless **Streak:** white when sofer than the streak plate **Luster:** vitreous **Diaphaneity:** transparent to translucent to nearly **Cleavage:** indistinct **Mohs hardness:** 7 to 7.5	Dravite $NaMg_3Al_6Si_6O_{18}(BO_3)_3(OH)_3OH$ Elbaite $NaMg_3Al_6Si_6O_{18}(BO_3)_3(OH)_3OH_2$ Schorl $NaFe_3Al_6Si_6O_{18}(BO_3)_3(OH)_3OH$
Garnet	 Hexaoctahedron, Trapezohedron, Dodecahedron	**Color:** Typically red, but can be orange, green yellow, purple, black, or brown. Blue garnets are extremely rare. **Streak:** Colorless **Luster:** vitreous **Diaphaneity:** transparent to translucent **Cleavage:** none **Mohs hardness:** 6.5 to 7.5	Almandine $Fe_3Al_2(SiO_4)_3$ Pyrope $Mg_3Al_2(SiO_4)_3$ Spessartine $Mn_3Al_2(SiO_4)_3$ Andradite $Ca_3Fe_2(SiO_4)_3$ Grossular $Ca_3Al_2(SiO_4)_3$ Uvarovite $Ca_3Cr_2(SiO_4)_3$
Feldspar	 Carslbad, Carslbad, Baveno, Manebach, Albite, Pericline	**Color:** usually white, gray, pink or brown. Also colorless, yellow, orange, red, black, blue, and green **Streak:** white **Luster:** vitreous. Pearly on some cleavage faces **Diaphaneity:** translucent to opaque. Rarely transparent **Cleavage:** perfect in two directions. Cleavage planes usually intersect at or close to a 90 degree angle **Mohs hardness:** 6 to 6.5	**Alkali feldspars** Ortoclase $KAlSi_3O_8$ Microcline $KAlSi_3O_8$ Anorthoclase $(Na,K)AlSi_3O_8$ **Plagioclase feldspars** Albite $NaAlSi_3O_8$ Oligoclase $(Na,Ca)(Al,Si)AlSi_2O_8$ Anorthite $CaAl_2Si_2O_8$

Figure 6: Important crystallographic, physical and chemical aspects of tourmaline, garnet and feldspar that are discussed during the field trip.

5. Final comments

The proposed report does not intend to fulfil major gaps in the regional geology of the visited area and is not directed to more experienced professionals. Instead, it is focused on the early development of the first-year geology students allowing a first(?) contact with the common pegmatite-related minerals such as quartz, feldspars, tourmaline, garnet, micas, among others in the field. It is highly recommended that all the theoretical aspects of Mineralogy are reviewed prior to the trip in order to facilitate the communication between the professors, involved graduate and undergraduate students and local miners that we might have the opportunity to be in touch during the work.

Of substantial importance is to review the main crystallography topics discussed in class, that will be crucial for the mineral identification as well as the physical properties of the rock forming minerals. The major focus will be given on the varieties of tourmaline, garnet and feldspar crystals and a well-developed skill on the physical properties of these minerals as well as their crystal habits are highly recommended to be synthesized as shown on Figure 6, which will be constantly discussed during the practical activity. To evaluate the didactical effectiveness of the field campaign the following quiz should be considered by the students:

1 – What does the “Borborema Pegmatite Province” concept is related with?

2 – Which minerals were seen during the field trip and what are their main diagnostic properties?

3 – Is there any preliminary genetic conclusion that can be

conjectured from the acquired field observations? Discuss in detail.

5 – Write an essay correlating the practical exercises made in class, those developed during the field trip and the theoretical part of the course. Be the most detailed as possible.

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