

The Namirróé – Nuaparra granitic pegmatites, Zambezia, Mozambique – Structure and mineralogy

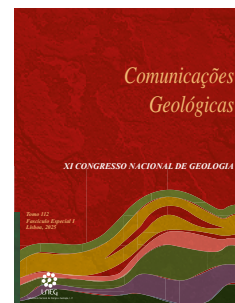
Pegmatitos graníticos de Namirróé – Nuaparra, Zambézia, Moçambique – Estrutura e mineralogia

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Abstract: At the core of the Granitic Pegmatite Province of Zambezia in Mozambique, in the Alto Ligonha Pegmatite District, a group of distinct types of pegmatites outcrop and are trapped by the same set of strike slip and overthrust structures. The most frequent are beryllium-rich with some Bi and Nb-Ta oxides (with anomalous contents of W). Their primordial, zoned, inner structure is well developed — giant crystals of K-feldspar at the intermediate zone are conspicuous, as is rose quartz in huge quantities at the cores. At close proximity, LCT typical pegmatites do occur. On the basis of mineralogy, structure, and cartography, and considering the paragenetic contrasts and the emplacement in the same set of large-scale structures of tectonic transport, it is reasonable to accept that this area corresponds to a material frontier between distinct districts or pegmatite fields.

Keywords: pegmatite, Zambezia, LCT, zoning, paragenesis.

Resumo: No núcleo da Província Pegmatítica granítica da Zambézia em Moçambique, no Distrito Pegmatítico do Alto Ligonha, aflora um grupo de tipos distintos de pegmatitos veiculados por um mesmo conjunto de estruturas de desligamento e carreamento. Os mais frequentes são berilíferos e bismutíferos com alguns óxidos de Nb-Ta (com teores anómalos de W). A estrutura interna primária zonada está bem desenvolvida – apresentam cristais gigantes de K-feldspato na zona intermédia, assim como quartzo róseo em grandes quantidades no núcleo. Na vizinhança imediata ocorrem pegmatitos LCT típicos. Com base na mineralogia, estrutura e cartografia, e considerando os contrastes paragenéticos e a localização no mesmo conjunto de estruturas megaescalares de transporte tectónico, é razoável aceitar que esta área corresponda a uma fronteira material entre distritos ou campos pegmatíticos distintos.

Palavras-chave: pegmatito, Zambézia, LCT, zonalidade, paragéneses.

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1. Introduction

Since the beginning of the 20th century, in the Nuaparra – Namirróé region, numerous granitic pegmatites have been identified and included in the Alto Ligonha pegmatite set (Barros and Vicente, 1963), equivalent to a pegmatite district, which, in its turn, is part

of the Zambézia pegmatitic province. According to Leal Gomes *et al.* (2008), in harmony with the spatial arrangement of regional structures of tectonic-transport, the Zambézia Pegmatite Province has a curvy and zoned organization, in which the Alto Ligonha pegmatite district assumes a central and more apical position in the stacking of transported mantles (Figura 1). Here, the Namirróé-Nuaparra group is located at the tectonic boundary of Alto Ligonha Pegmatite District. In the studied area, the regional rocks are attributed to the Molocué complex (Molocué Group, according to AQUATER, 1983) being constituted by composite gneisses, derived from meta-pelitic and meta-psammitic sequences, also including intercalations of meta-carbonate rocks and volcanogenic facies of bimodal primitive nature. A thematic cartography was carried out (Figura 2), considering, in particular, the anatomy of the pegmatites, which were also subjected to detailed structural analysis. Its minerals, separated by contrast of physical properties, were subjected to identification by x-ray diffractometry (XRD) and by energy dispersion spectrometry in a scanning electron microscope (SEM – EDX). One objective of this study is to show that the structural hosting of pegmatite groups may represent a material boundary between transported terrains with different geochemical lineages and classes of pegmatite bodies. This was already perceptible in the broader scale mapping of the district boundaries inside the Pegmatite Province of Zambezia (Leal Gomes *et al.*, 2008). The markers that are used to discriminate the paragenesis, classes and families are the following: composition and XRD characterization of micas and oxide minerals of Nb, Ta, Ti and W; XRD identification and intergrowths of phosphates and Be minerals and XRD identification and polychromy of tourmalines. In general terms, pegmatites shape, size and inner - structure are attributed to early trapping in overthrust structures and modified by late transcurrent shear (Figura 2). Shear reactivations and/or relaxations triggered successive dilatational events and the overlap of magmatic to hydrothermal episodes and paragenesis.

2. Structural and paragenetic analysis

Paragenesis with contrasting specialization – LCT and non LCT - are well represented in two main poles of the pegmatite group (Figura 2):

- eastern pole – the pegmatites hold beryl, Nb-oxides rich in columbite molecule (with W-rich terms), and scattered bismutite spots; they are K-rich with a primary inner-zoning characterized by a core with large volumes of rose quartz and giant feldspars in a



Figure 1. Alto Ligonha pegmatite district and main distribution of individualized pegmatite groups. 1 – Main Li, Cs, Ta pegmatites; 2 – non - Li, Cs, Ta pegmatites; 3 – rivers; 4 – main roads; 5 – towns; 6 – Namirróé-Nuaparra area; 7 – overthrust lineaments; 8 – mantles stacking of Nuaparra (duplex or flower structure), lodging different pegmatite families. Adapted from Leal Gomes *et al.* (2008).

Figura 1. Distrito pegmatítico do Alto Ligonha e distribuição principal dos grupos pegmatíticos individualizados. 1 – Pegmatitos principais de Li, Cs, Ta; 2 – pegmatitos não-Li, Cs, Ta; 3 – rios; 4 – estradas principais; 5 – vilas; 6 – Zona Namirróé-Nuaparra; 7 – lineamentos de carreamento; 8 – empilhamento de mantos de Nuaparra (estrutura em duplex ou flor), alojando diferentes famílias de pegmatitos. Adaptado de Leal Gomes *et al.* (2008).

comb-structure arrangement, composing the intermediate zone; in the marginal zones, Mn-almandine garnet and some schorl tourmaline are found – open pit C2 in figure 2 is a good example of this non-LCT type (Figure 3).

- western pole - pegmatites with LCT signature, contain several types of Li-rich micas (lepidolite, polyolithionite, trilithionite, masutomilite and Li-muscovite), abundant Cs-rich beryl, frequent topaz, occasional spodumene and rare Nb-Ta oxides, prevailing Ta-rich molecules (microlite and Sb-tantalite are present); tourmaline is frequent, with compositional terms ranging from the composition of schorl to the compositions of elbaite, foitite and liddicoatite; the wall zone shows spessartite and ghanite – C5 pit cuts one of these bodies (figure 4).

3. Inner structures and minerals indicating advanced fractionation

Structures typical of the most fractionated compartments of the LCT pegmatite from C5 pit are illustrated in figure 5.

Table 1 presents some extreme values of mineral chemical parameters obtained for separated muscovite fractions of this same pegmatite group (white to lavender colors) (Lopes Nunes, 1973 and Lopes Nunes *et al.*, 2003), indicating an advanced stage of evolution in the LCT paragenetic sequence.

For the all set of Namirróé - Nuaparra muscovites – from non LCT and LCT pegmatites – considering the alkaline metals - Lopes Nunes (1973) noticed a compositional discrimination of several populations, which could be considered representative of the degree of fractionation and so, of the stage of paragenetic evolution of the host-pegmatites (Figura 6).

As such, Li/Cs relation discriminates 3 compositional populations of muscovites from LCT pegmatites and K/Rb, 2 compositional populations

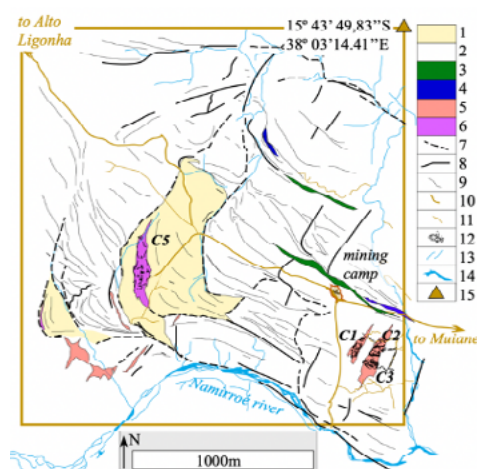


Figure 2. Simplified geological map of Namirróé – Nuaparra claim. 1 – allochthonous terrains tectonically transported to SW – amphibole-rich gneisses with magnetite and interlayered mica schist; 2 - heterogeneous gneisses and amphibole migmatites including talc to chlorite lenses; 3 – levels of tourmaline and chlorite sometimes with amphibole and metasomatic calc-silicates; 4 - quartzite; 5 – non LCT pegmatites; 6 – LCT pegmatites; 7 – probable faults; 8 – confirmed strike-slip and overthrust structures; 9 - trajectories of gneiss and schist foliations and migmatite veining; 10 – major bush roads; 11 – trails; 12 – mining works; 13 - small seasonal creeks; 14 – large ponds and permanent river course; 15 – landmark for geographical reference.

Figura 2. Mapa geológico simplificado da região Namirróé – Nuaparra. 1 – terrenos alóctones tectonicamente transportados para SW – gnaisses ricos em anfíbola com magnetite e micaxistos intercalados; 2 - gnaisses heterogêneos e migmatitos anfíbólicos incluindo lâminas de talco a clorito; 3 – níveis de turmalina e clorite, por vezes com anfíbola e calcossilicatos metassomáticos; 4 - quartzito; 5 – pegmatitos não LCT; 6 – Pegmatitos LCT; 7 – falhas prováveis; 8 – estruturas de deslignamento e carreamento confirmadas; 9 - direção das foliações gnáissicas e xistosas e veios migmatíticos; 10 – picadas; 11 – trilhos; 12 – obras de mineração; 13 – pequenos riachos sazonais; 14 – grandes lagoas e cursos fluviais permanentes; 15 – marco geodésico.

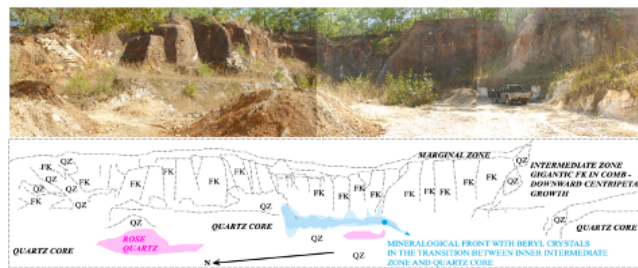


Figure 3. Projection in vertical elevation, N15°E, of the front of cut C2 after recent ripping – Be, Nb and Bi - pegmatite. FK – giant crystals of perthite; QZ – huge masses of milky to rose quartz.

Figura 3. Projeção em elevação vertical, N15°E, da frente do corte C2 após extração recente – Be, Nb e Bi - pegmatito. FK – cristais gigantes de perite; QZ – enormes massas de quartzo leitoso a rosa.

for muscovites of non LCT pegmatites. This also denotes the conspicuous growing content of Cs during LCT fractionation and the more typical increase in Rb associated with the non LCT differentiation. Textural and chromatic observations and XRD characterization of muscovites and other Li-micas are consistent with these findings. The correlation Li/Cs in figure 6 exhibits an aligned dispersion of clusters (cloud plots) in accordance with what seems to be a multistage deposition of mica, associated with oscillatory primary fractionation and/or polycyclic reactivation of shear structures and associated hydrothermal alteration.

In each type of pegmatite, the muscovites of the border zones have higher K/Rb and K/Cs ratios than those that, with the same

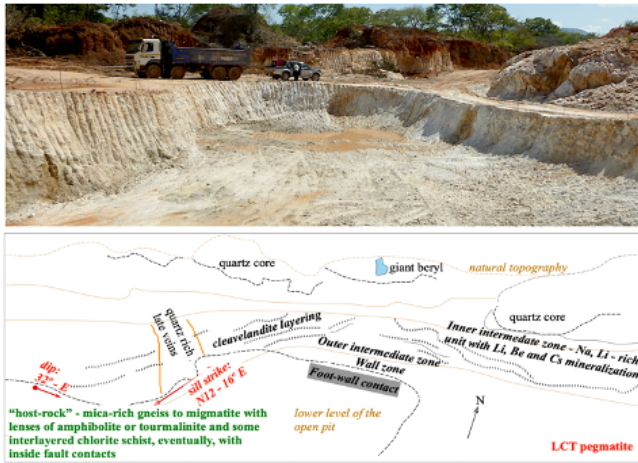


Figure 4. South to North view of the C5 open pit – highly differentiated Li, Cs, Ta-rich pegmatite (LCT).

Figura 4. Vista sul-norte da mina a céu aberto C5 – pegmatito altamente diferenciado rico em Li, Cs e Ta (LCT).

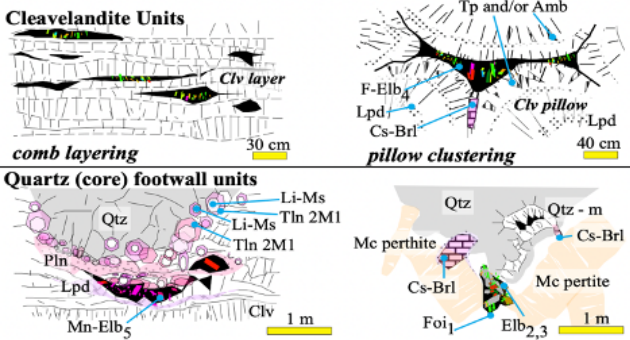


Figure 5. Descriptive analysis of mineral arrangements related to paroxysmal evolution of the LCT pegmatite exposed in C5 open pit. Mc-microcline; Qtz-quartz; Qtz-m-miarolitic quartz; Clv - cleavelandite; Li-Ms - Li-muscovite; Tln - trilitionite; Pln - polyolithionite; Lpd-lepidolite ; Mn-Elb – Mn-elbaite ; F-Elb – F-elbaite ; Elb(n) – elbaite generation ; Cs-Brl – Cs-beryl ; Tp - topázio ; Amb – ambligonite - montebrasite. 2M1 – XRD deduced polytype.

Figura 5. Análise descritiva dos arranjos minerais relacionados com a evolução paroxística do pegmatito LCT exposto na mina a céu-aberto C5. Mc-microclina; Qtz-quartzo; Quartzo Qtz-m-miarolítico; Clv - cleavelandite; Li-Ms - Li-moscovite; Tln - trilitionite; Pln - polilitionite; Lpd-lepidolite; Mn-Elb – Mn-elbaite; F-Elb – F-elbaite; Elb(n) – geração de elbaite; Cs-Brl – Cs-berilo; Tp - topázio; Amb – ambligonite – montebrasite. 2M1 – Polítipo deduzido por XRD.

Table 1. Elements and its relations suggesting the paroxysmal evolution of LCT lineage in Li-rich muscovites of the LCT sequence from Namirróé – Nuaparra – compositional values in ppm (Lopes Nunes, 1973 and Lopes Nunes *et al.*, 2003).

Tabela 1. Elementos e suas relações que sugerem a evolução paroxística da linhagem LCT em moscovites ricas em Li da sequência LCT de Namirróé – Nuaparra – valores composicionais em ppm (Lopes Nunes, 1973 e Lopes Nunes *et al.*, 2003).

Pegmatite	Li	Rb	Cs	K	K/Rb	K/Cs
NR – C5	15699	26691	7198	74350	2.79	10.33
NR – C5	11898	21759	5106	77312	3.55	15.14
NR – C5	5811	20002	2827	77241	3.86	27.32
NR – C5	7860	19733	3307	73889	3.74	22.34

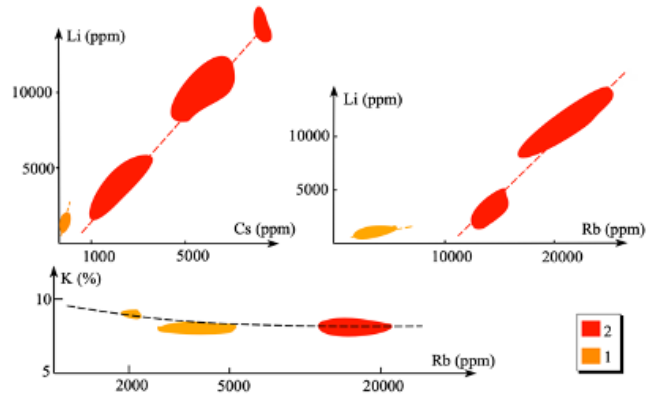


Figure 6. Alkaline metals correlations among differentiated muscovite terms, considering texture and color (data from Lopes Nunes, 1973). 1 – non LCT pegmatite; 2 – LCT pegmatite.

Figura 6. Correlações de metais alcalinos entre termos diferenciados de moscovite, considerando textura e cor (dados de Lopes Nunes, 1973). 1 – pegmatito não LCT; 2 – Pegmatito LCT.

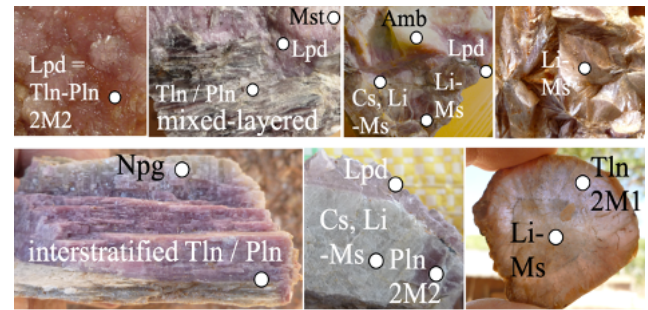


Figure 7. Different morphologies, habits and aggregates of micas located at the base of the quartz core (figura 5) materializing a possible boundary layer. Minerals symbols are identical to those of figura 5; in addition: Cs, Li Ms – Cs-rich Li-Muscovite; Mst – masutomilite; 2M2, 2M1 – XRD deduced polytypes.

Figura 7. Diferentes morfologias, hábitos e agregados de micas localizados na base do núcleo de quartzo (Figura 5) materializando uma possível camada limite. Os símbolos dos minerais são idênticos aos da figura 5; em adição: Cs, Li Ms – Li-moscovite rica em Cs; Mst – masutomilite; 2M2, 2M1 – Polítipos deduzidos por XRD.

morphological and textural aspect, are located close to the quartz cores. In general, the lowest K/Rb and K/Cs values in muscovites are found in pegmatites where Na-Li paragenesis predominate.

All early muscovites from the non-metasomatized zones of Na-Li-rich pegmatites are Ba- and Sr-poor. On the contrary, in the case of non LCT pegmatites, muscovites may have higher Ba content (Lopes Nunes *et al.*, 2003).

In what concerns all mica varieties of the most evolved LCT pegmatites, figure 7 illustrates some representative examples, separated by color, texture, host assemblage and XRD characterization. Combining crystal intergrowths in units of quartz-core footwall (Figura 5) and correspondent Li-mica types of figure 7, it seems that they represent the formation of a mineral front at the bottom of core masses of quartz, equivalent to a boundary layer (London, 2005), defined inside the primitive fractionation chamber.

The same type of units, probably materializing boundary layers, hold several phosphate minerals, compatible with highly evolved stages of fractionation, which include Li, Cs-rich micas (Figura 8).

Tourmaline, as was suggested, in figure 5, reveals a polychrome diversity developed in accordance to the hosting paragenetic stage of evolution inside the pegmatite. Multicolored, light colored and pink elbaite-lidicoatite

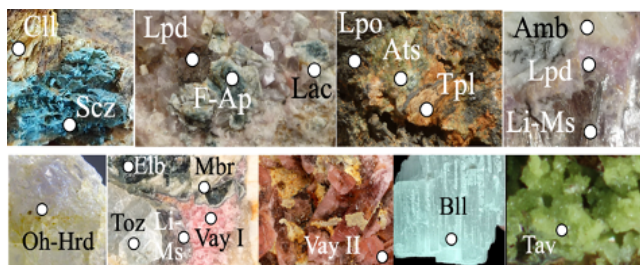


Figure 8. Phosphate differentiation in boundary layer environments according to Londo, (2005). Symbols as in figura 5. Additionally: F-apatite - F-Ap, collinsite - Cll, althausite - Ats, goedkinitite - Gdk, scorzalite - Scz, triploidite - Tp, lacroixite - Lac, Bll - beryllonite, OH-Hrd - OH-herderite, Vay - Vayrinenite, montebrasite end member - Mbr, Tav - Tavorite.

Figura 8. Diferenciação de fosfato em ambientes de camada limite, de acordo com Londo, (2005). Símbolos como na figura 5. Adicionalmente: F-apatite - F-Ap, collinsite - Cll, althausite - Ats, goedkinitite - Gdk, escorzalite - Scz, triploidite - Tp, lacroixite - Lac, Bll - berilonite, OH-Hrd - OH-herderite, Vay - Vayrinenite, membro final da montebrasite - Mbr, Tav - Tavorite.

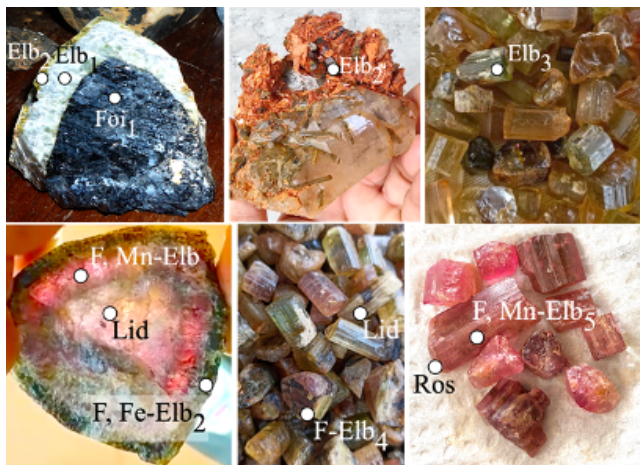


Figure 9. Multicolor terms of tourmaline from different paragenetic stages of LCT pegmatites. Foi1-primitive foitite; Elbn-elbaite of different successive generations; Ros - rossmanite, Lid - lidoicoatite.

Figura 9. Termos multicoloridos de turmalina de diferentes estágios paragenéticos de pegmatitos LCT. Foi1-foitite primitiva; Elbn-elbaite de diferentes gerações sucessivas; Ros - rossmanite, Lid - lidoicoatite.

and rossmanite are typical of LCT paroxysm assemblages. Instead foitite appears in early stages of quartz core individualization (Figura 9). Non LCT pegmatites only have schorl.

Also, there is a definite relationship between the tendencies of internal pegmatitic fractionation, revealed by the mineral chemistry of Nb-Ta oxides and those established in the case of micas - higher contents of Ta and Mn apfu in the oxides that are in paragenesis with micas richer in Li, Rb and Cs.

Table 2 illustrates representative compositions of Ta-Nb oxide minerals from different rare element pegmatite families and also different paragenetic positions inside the individual bodies.

In non LCT pegmatites of Nuaparra, as Saari *et al.* (1968) referred, some compositions approach that of Nb - wolframite. A primary Nb-ferberite revealed low concentration of Ti, Sc, Sn, Sb, Pb, U, Th, Na and Y. According to Saari *et al.* (1968) compositions such as these represent an intermediate solid solution between ferberite $FeWO_4$ and a $FeNbO_4$ phase.

Paragenesis of LCT pegmatites have low modal percentages of Nb-Ta oxides, however the Ta content of these are the highest when compared to

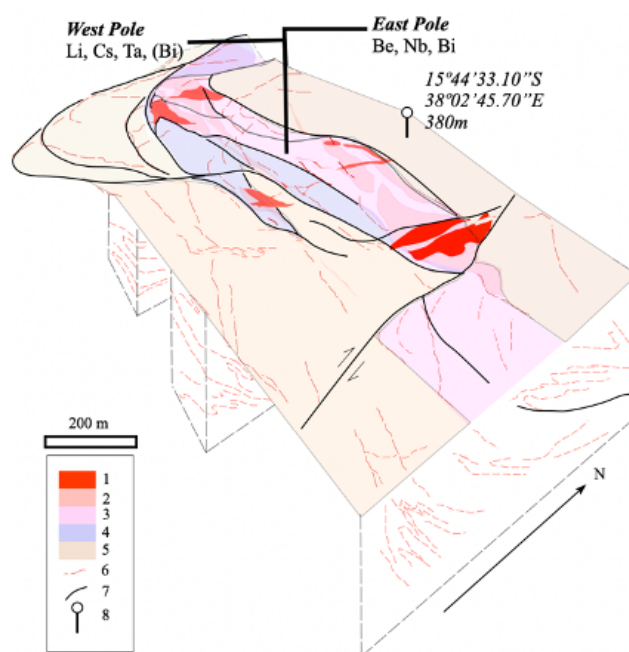


Figure 10. 3d conceptual generalization of the succession of mantles transported from the Molocué Group (AQUATER, 1983) and associated pegmatitization in the Namirróé-Nuaparra compartment of the Alto-Ligonha pegmatitic district (Leal Gomes *et al.*, 2008). 1 - pegmatites; 2 - gneissic rocks with restites and veins, petigmatic or not, quartz-tourmaline-rich and pegmatitic, also with tourmaline; 3 - heterogeneous gneisses to migmatites with tourmaline; 4 - migmatitic rocks, with intercalations of amphibolites and amphibolic-tourmaline micaschists (Na-amphibole); 5 - polygenic regional gneisses, including orthogneisses with orthoclase, biotite and magnetite; 6 - metamorphic surfaces and metassomes including, gneissic foliations, micaceous-amphibolic "schlieren", leucocratic segregation veins and also the more penetrative slaty cleavage; 7 - ductile discontinuities with displacement criteria indicating variable tectonic transport from tangential to transcurrent, sometimes materialized by faults with occasional breccias and late quartz veins, carriers of gold mineralization; 8 - vertex for geographic reference of the schematic compartment.

Figura 10. Generalização conceitual 3d da sucessão de mantos transportados do Grupo Molocué (AQUATER, 1983) e pegmatitização associada no compartimento Namirróé-Nuaparra do distrito pegmatítico Alto-Ligonha (Leal Gomes *et al.*, 2008). 1 - pegmatitos; 2 - rochas gnaissicas com restites e filões, petigmáticas ou não, ricas em quartzo-turmalina e pegmatíticas, também com turmalina; 3 - gnaisses heterogêneos a migmatitos com turmalina; 4 - rochas migmatíticas, com intercalações de anfibolitos e micaxistos anfibólico-turmalinos (Na-anfibola); 5 - gnaisses regionais poligênicos, incluindo ortogneisses com ortoclase, biotite e magnetite; 6 - superfícies metamórficas e metassomas, incluindo, foliações gnaissicas, "schlieren" micáceo-anfibólicos, veios de segregação leucocrática e também a clivagem xistosa mais penetrativa; 7 - descontinuidades dúcteis com critérios de deslocamento indicando transporte tectônico variável de tangencial para transcorrente, por vezes materializado por falhas com brechas ocasionais e veios tardios de quartzo, portadores de mineralização de ouro; 8 - vértice para referência geográfica do compartimento esquematizado.

the terms from non LCT bodies, occurring nearby. In this case the contents of Ta are low in absolut terms.

4. Concluding remarks

As revealed by the extreme mineral and mineral - chemical diversity, the Namirróé - Nuaparra group represents a multi-compositional set of pegmatites with differentiated paragenetic features, hosted in the same structural stacking: strongly differentiated LCT and little evolved hybrid LCT/NYF, noted as non LCT (Figura 10). The trapping sites for pegmatite prior melt/fluid composites seem to have been generated by tangential to transcurrent shear in positions different to those currently observed. They mark what seems to be a flower structure.

Probably, superimposed overthrust transport was also responsible

Table 2. Representative chemical compositions (points analyzed in electron microprobe, values in weight per cent) in polished sections of macro-crystals of oxides with Nb and Ta, also characterized by XRD. W-Ixl – wolframioxiolite, Wdg – wodginitite, Nb-Wol – niobian wolframite, Nb-Fbr – niobian ferberite, Mic – microlite, Tap – tapiolite, Sb-Tnt – stibiotantalite, Bi-Tnt – bismutotantalite, Nb-Rt – Nb-rich rutile, Ta - Rt – Ta-rich rutile. Fe O* - all Fe as Fe O; – not determined, not analyzed or below detection limit. 1 to 5 – LCT pegmatites. 6 to12 – contiguous non LCT pegmatites.

Tabela 2. Composições químicas representativas (pontos analisados em microsonda eletrônica, valores em porcentagem de peso) em seções polidas de macrocristais de óxidos com Nb e Ta, também caracterizados por DRX. W-Ixl – volframoixiolite, Wdg – wodginitite, Nb-Wol – volframite nióbia, Nb-Fbr – ferberite nióbia, Mic – microlite, Tap – tapiolite, Sb-Tnt – estibiotantalite, Bi-Tnt – bismutotantalite, Nb-Rt – Nb- rutilo rico, Ta - Rt – rutilo rico em Ta. Fe O* - todo Fe como Fe O; – não determinado, não analisado ou abaixo do limite de detecção. 1 a 5 – Pegmatitos LCT. 6 a 12 – pegmatitos não LCT contíguos.

	1 Wdg	2 Mic	3 Tap	4 Sb-Tnt	5 Bi-Tnt	6 Nb-Rt	7 Ta-Rt	8 W-Ixl	9 Nb-Wol	10 Nb-Wol	11 Nb-Wol	12 Nb-Fbr
Ta ₂ O ₅	65.10	77.80	82.11	55.40	42.01	11.15	32.05	-	4.14	2.92	-	0.97
Nb ₂ O ₅	7.58	3.22	3.30	3.40	5.58	22.81	15.20	35.06	31.60	25.09	17.20	9.91
Mn O	10.39	-	1.92	-	-	0.19	0.62	4.51	10.11	9.11	5.40	2.12
Fe O*	4.00	-	12.96	-	-	11.95	13.20	14.01	7.24	11.01	12.71	18.84
Ca O	0.20	10.61	-	-	-	-	-	-	-	-	-	-
Na ₂ O	-	4.12	-	-	-	-	-	-	-	-	-	-
Ti O ₂	1.82	0.02	0.35	-	-	44.99	32.50	5.25	1.90	2.22	3.00	0.35
Sn O ₂	8.20	0.01	-	-	-	2.97	3.52	-	0.30	0.41	-	-
Sc ₂ O ₃	0.15	-	0.03	-	-	0.15	0.09	-	0.02	0.05	4.18	1.64
Sb ₂ O ₃	-	-	-	37.51	1.19	-	-	-	-	-	-	-
Bi ₂ O ₃	-	-	-	3.60	45.41	-	-	-	-	-	-	-
Y ₂ O ₃	0.04	-	-	-	-	-	-	-	-	-	-	-
W O ₃	1.02	-	-	-	-	0.99	0.40	41.32	42.36	48.10	56.02	60.97
U ₃ O ₈	0.06	-	-	-	-	-	-	-	0.15	0.06	-	-
F	-	2.87	-	-	-	-	-	-	-	-	-	-

for the observed proximity between contrasting rare elements types of pegmatites.

These contrasting paragenetic types, located in the same compartment of regional rocks, indicate the reactivation, in different episodes, of a shearing fulcrum (duplex) with a cartographic mega scale expression (Figura 10) with kinematic indicators, which can be attributed to early and late episodes of Pan-African orogenic event (from tangential transport to shortening and transcurrent retouches).

It does not seem to exist a cogenetic link between the more contrasting pegmatites. Thus, it is assumed that they belong to different lineages.

The earliest bodies are the richest in mineralization of Be, Nb, Bi and T.R. The later ones are richer in Li, Cs and Ta (LCT type), and may also present Bi. Structural and paragenetic criteria suggest that the former may be more directly related to partial melting and primitive anaxesis. Instead, although not so clearly, LCT ones may derive from a residual fractionation from specialized granitic magmas. Considering signals of overthrust trapping of precursor magmas and fluids (crystal growth structures at marginal zones of the pegmatites) and post crystallization overthrust motion (superimposed structures at the contacts and neighboring host-rock), it is hypothesized that this diversity of families, hosted in close proximity in the space, is indicative of the outcrop of a structural frontier between distinct neighboring districts or pegmatite fields. This is a fact of some importance given that the limits of regional divisions are almost always deduced and rarely materialized by abrupt contrasts of structure and paragenesis in almost contiguous pegmatite bodies.

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