Uncommon Nb-tantalate from the Cachoeira mine, Araçuaí pegmatite district (Minas Gerais)

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Abstract

Important spodumene-rich pegmatites have been mined by CBL (Companhia Brasileira de Lítio, Brazilian Lithium Co.) at the Cachoeira mine (northeastern Minas Gerais state) since the 1990's. In this deposit, black platy crystals resembling columbite-tantalite are also found; they were analyzed by electronic microprobe as part of the first author's master's degree dissertation. The Cachoeira pegmatite group comprises several spodumene-rich bodies that consist of pertitic microcline, spodumene (on average 23vol%), albite, quartz and muscovite, totalizing more than 95% of the bodies' volume. Analyses on 27 samples of supposedly Nb-tantalates showed a high variation of Ta, Nb and Sn contents, which has been observed inclusive in individual crystals, causing color variation on backscattered electrons images. Surprisingly, analyses on some grains also revealed the presence of ixiolite, a mineral species that has never been described in that region; it is characterized by high SnO_2 contents (up to ~16wt%). Columbite-(Fe) phase represents 42% of total Nb-tantalates analyzed samples, tantalite-(Fe) 19%, columbite-(Mn) 3% and ixiolite, 36%. Cassiterite, also observed, shows significant Ta_2O_5 contents, probably indicating general exsolution processes.

Keywords: Nb-tantalates, ixiolite, Cachoeira mine, spodumene, Araçuaí pegmatite district.

1. Introduction

Since the 1990's CBL (Companhia Brasileira de Lítio, Brazilian Lithium Co.) has mined important spodumene-rich pegmatites at the Cachoeira mine, on the border between Araçuaí and Itinga counties (northeastern Minas Gerais state), around 18 km (by road) to the east of Araçuaí town (Figure 1). UTM coordinates from the office area are 189720/8142540 (305 m). Such pegmatite bodies are inserted in the Araçuaí district of the Eastern Brazilian Pegmatite Province (EBP), defined by Paiva (1946). The mining seeks mainly "industrial" spodumene ($LiAlSi_2O_6$) in order to obtain lithium salts. In this deposit, black minerals resembling columbite-tantalite are found, and 27 samples were analyzed by electronic microprobe as part of the first author's master's degree dissertation.

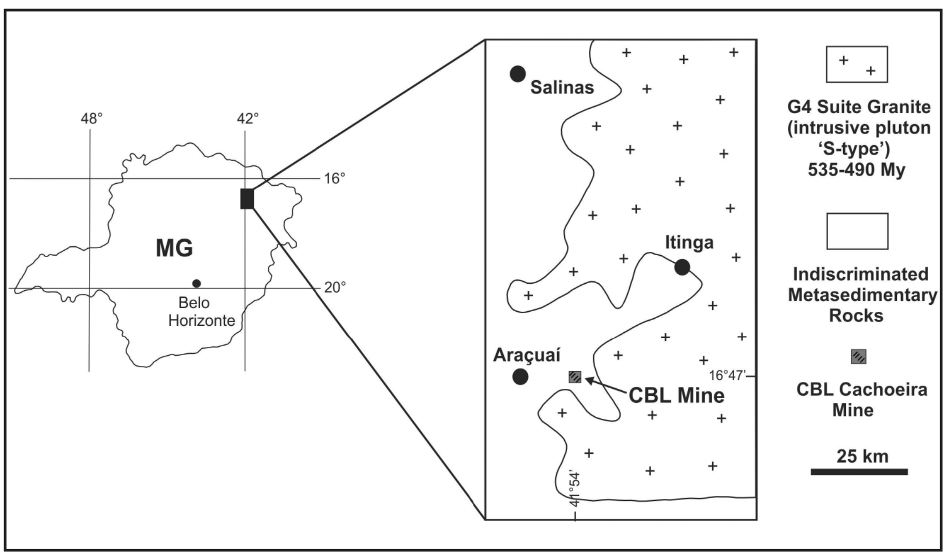

Figure 1
CBL Cachoeira mine localization eastern of Araçuaí town (modified from Romeiro and Pedrosa-Soares, 2005).

Minerals from the columbite-tantalite series are the most common Nb-tantalates found in granitic pegmatites, mainly occurring as solid solutions. Their generic formula is AB_2O_6, where the A site is normally occupied by Fe or Mn, and the B site is generally filled by Nb, Ta, Sn and Ti cations (Černý *et al.*, 1998; Martins *et al.*, 2011). They are orthorhombic, crystallizing with Pbcn structure, and their true cell has: a ~14.4 Å, b ~5.8 Å and c ~5.1 Å (Grice *et al.*, 1976). In such series, it is reported that the Mn:Fe ratio increases according to the fractionation within a body or pegmatite group. Likewise, it is expected that the Ta:Nb ratio growth follows the chemical fractionation degree (Martins *et al.*, 2011). According to Burke (2008), end-members of this series are currently designated as tantalite-(Fe), tantalite-(Mn), columbite-(Fe) and columbite-(Mn).

Ixiolite represents a columbite substructure, with the cations in disordered arrangement; its generic formula can be written as $(A,B,C)_4O_8$, where all metals occupy the same site, $A=Fe^{2+},Mn^{2+}$; B=Nb,Ta; C=Sn,Ti (Palache *et al.*, 1944; Nickel *et al.*, 1963; Grice *et al.*, 1976). According to Wise *et al.* (1998), orthorhombic ixiolite structure reverts, after heating, to an ordered (monoclinic) wodginite cell. There is a controversy about ixiolite structure and crystallography. Most of authors described ixiolite as orthorhombic (e.g. Nickel et al., 1963; Grice *et al.*, 1976; Černý *et al.*, 1998); some mineralogical websites, however, state that the structure is monoclinic (e.g. Handbook of Mineralogy, 2015; Web Mineral, 2015). In relation to crystallography, Grice *et al.* (1976) have refined the structure, obtaining: a=4.785(2), b=5.758(2) and c=5.160(2).

2. Geological setting

Most pegmatites of the Araçuaí district are the results of the crystallization of residual melts from post-collisional G4-type granites, which intruded between 535 Ma and 490 Ma (Pedrosa-Soares *et al.*, 2011). Main host rocks are biotite schists with variable contents of andaluzite, cordierite and sillimanite of the Salinas Formation. The low pressure metamorphic silicates (andaluzite and cordierite), the presence of petalite in some pegmatites and the quantitative geothermobarometric data suggest a relatively shallow crustal level (5 to 10 km) for these pegmatites. The intrusions occurred along the regional foliation and short fracture systems, generally dipping to SE or NW in the Salinas schists (Correia-Neves *et al.*, 1986).

Main geological descriptions of the CBL mine are based on Romeiro (1998) and Romeiro and Pedrosa-Soares (2005). The Cachoeira pegmatite group is constituted by a swarm of spodumene-rich pegmatites (Figure 2a), which are roughly tabular bodies with lens-shaped terminations. They range in thickness from decimeters up to 30 m and in length from a few meters to more than 300 m along the strike. The bodies and their segments form an array of en echelon pattern, and consist of pertitic microcline, spodumene (on average 23vol%), albite, quartz and muscovite, totalizing more than 95% of the body volume. Montebrasite, beryl, cassiterite, cookeite and lithiophosphate are other rare accessory minerals.

According to the same authors, CBL pegmatites intruded along two different NE-striking surfaces of medium- to high-angle dip: the NW-dipping schistosity and the SE-dipping fracture cleavage. These pegmatites always show sharp contacts with the host rock (Figure 2b) and a discontinuous, thin, fine-grained chilled margin (that could be interpreted as a marginal zone of granitic texture). No internal zoning can be seen, although variations of crystal size occur in specific sites, such as tops and low-angle dip segments of the pegmatites. Despite of the pegmatites thickness, they are homogeneous bodies with spodumene, as well as the other disseminated essential minerals, as Nb-tantalates (Figure 2c). Such important factor favors the current mining process.

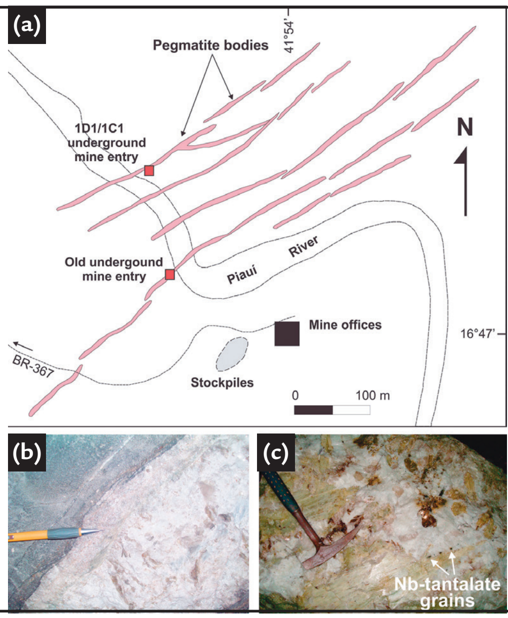

Figure 2
(a) Cachoeira pegmatite group map showing pegmatite bodies (including projections from subsurface) of the CBL mine area, modified from Romeiro (1998).
(b) Sharp contact between the pegmatite and the host rock.
(c)Detail of millimetric size Nb-tantalate grains (dark) in a feldspar--spodumene-(quartz) matrix (light).

Sá (1977) presented an age of 467 ±18 Ma for the Cachoeira pegmatites, which were dated by the K-Ar method in muscovite. According to Černý and Ercit (2005) classification scheme, such bodies can be inserted in the rare-element class, Li subclass, albite-spodumene type.

3. Chemical mineralogy - Results

The 27 sampled crystals vary in size from millimeters to around 2.5 cm; they are generally platy and striated parallel to (110), the same plane as the cleavage. Samples were set up in polished sections, and the analyses were

	Ta_2O_5	Nb_2O_5	FeO	MnO	SnO_2	TiO_2	UO_2	Total	Ta/Nb atomic ratio	Species
Am1	30.55	48.13	11.76	7.54	0.65	1.09	0.28	100.01	0.38	columbite-(Fe)
Am2	39.14	40.29	10.35	8.16	0.66	0.62	0.06	99.27	0.58	columbite-(Fe)
Am3	22.19	54.56	13.82	5.91	0.85	1.81	0.08	99.23	0.24	columbite-(Fe)
Am4	42.20	37.30	10.26	8.51	0.71	0.54	0.04	99.57	0.68	columbite-(Fe)
Am5	20.11	57.36	14.16	6.32	0.75	1.71	0.13	100.53	0.21	columbite-(Fe)
Am6	22.21	54.75	14.07	6.01	1.25	2.00	0.08	100.37	0.24	columbite-(Fe)
Am7	52.62	17.52	8.85	5.12	13.51	1.30	0.07	98.99	-	ixiolite
Am8	49.46	31.24	8.54	9.42	0.62	0.36	0.10	99.72	0.95	columbite-(Mn)
Am9a	47.57	30.39	10.75	6.72	1.69	2.03	0.29	99.44	0.94	columbite-(Fe)
Am9b	53.36	16.85	8.88	5.48	13.59	1.28	0.06	99.50	-	ixiolite
Am10	30.94	47.79	11.92	7.68	0.66	0.93	0.17	100.08	0.39	columbite-(Fe)
Am11	21.06	55.25	13.81	6.03	0.85	1.60	0.21	98.81	0.23	columbite-(Fe)
Am12	61.28	9.46	7.60	6.16	14.66	1.04	0.07	100.02	-	ixiolite
Am13	58.17	11.25	7.83	5.98	15.83	0.56	0.03	99.49	-	ixiolite
Am14	31.98	46.78	13.08	6.52	0.69	1.20	0.02	100.19	0.41	columbite-(Fe)
Am15	41.40	37.03	11.39	7.00	0.73	1.27	0.05	98.85	0.67	columbite-(Fe)
Am16a	50.64	27.97	11.97	4.92	1.55	2.21	0.07	99.19	1.09	tantalite-(Fe)
Am16b	52.00	24.23	11.31	4.65	4.08	1.99	0.05	98.01	1.29	tantalite-(Fe)
Am17a	38.19	40.36	12.24	6.13	0.88	1.45	0.06	99.50	0.57	columbite-(Fe)
Am17b	58.60	11.07	8.25	4.92	13.69	3.15	0.04	99.70	-	ixiolite
Am18a	57.00	23.22	10.69	6.19	0.87	1.22	0.00	98.96	1.48	tantalite-(Fe)
Am18b	57.67	11.40	8.80	4.96	14.66	2.07	0.02	99.61	-	ixiolite
Am19	50.96	27.23	12.00	5.42	1.25	1.84	0.05	98.58	1.13	tantalite-(Fe)
Am20a	18.57	58.73	14.88	6.97	0.77	1.46	0.13	101.24	0.19	columbite-(Fe)
Am20b	49.46	29.13	11.84	5.27	1.34	1.69	0.07	98.78	1.02	tantalite-(Fe)
Am21a	56.98	23.75	10.93	6.09	0.60	1.17	0.08	99.47	1.44	tantalite-(Fe)
Am21b	57.19	11.75	9.05	4.29	15.08	2.85	0.06	100.10	-	ixiolite
Am22a	52.87	14.43	9.14	4.59	15.35	1.30	0.02	97.76	-	ixiolite
Am22b	57.23	11.24	9.23	4.44	13.96	3.40	0.04	99.31	-	ixiolite
Am23	59.43	12.21	7.90	6.24	11.40	1.43	0.09	98.60	-	ixiolite
Am24	57.58	14.02	8.45	6.02	11.24	1.32	0.09	98.75	-	ixiolite
Am25	6.70	0.70	1.45	0.02	91.78	0.60	0.03	101.28	-	cassiterite
Am26	6.56	0.72	1.43	0.05	92.27	0.61	0.02	101.67	-	cassiterite
Am27	5.75	0.62	1.13	0.08	93.68	0.57	0.03	101.86	-	cassiterite

Table 1
Electronic microprobe analyses of Nb-tantalates and cassiterite from the CBL Cachoeira mine (wt. %; averages of 4 or 5 spots; total iron as FeO; analyses "a" and "b" show distinct compositions within the same grain).

carried out at the microanalysis lab (LAMIN) at the Physics Department – Federal University of Minas Gerais, with JEOL-JXA8900R electron microprobe. An accelerating potential of 15 kV, a specimen current of 20 nA and a beam diameter about 20 μm were used, with the following standards: metal – Ta_2O_5, rodonite – MnO, cassiterite – SnO_2, magnetite – FeO, UO_2 – UO_2, rutile – TiO_2, metal – Nb_2O_5, and metal – WO_3. Images of backscattered electrons were also locally taken in order to evidence possible compositional variations.

According to Table 1, a great variation of Ta, Nb and Sn contents in Nb-tantalates from the Cachoeira mine can be observed. For analyzed columbite-tantalites, Ta_2O_5 contents range between 18.57 and 57.00wt%; Nb_2O_5 between 23.22 and 58.73wt%; and Sn between 0.60 and 4.02wt%. According to Betejtin (1977), SnO_2 contents in tantalites can reach 2wt%, and rarely up to 9wt%. Some samples turned out to be ixiolites, with Ta_2O_5 contents ranging between 52.62 and 61.28wt%; Nb_2O_5 between 9.46 and 17.52wt%; and Sn between 11.24 and 15.83wt%.

Fe and Mn contents vary in a shorter range: for columbite-tantalites, between 8.54 and 14.88wt%, and 4.64 and 9.42wt%, respectively; for ixiolites, between 7.60 and 9.23wt%, and 4.29 and 6.24wt%, respectively. Due to short Fe-Mn variation, relative contents of Nb, Ta and Sn of the samples were emphasized in an oxide Ta-Nb-Sn ternary diagram (constructed with Minpet software). The three analyzed cassiterite samples are Ta-rich and Nb-poor. According to Dunn *et al.* (1978), about 11wt% Ta_2O_5 might be a maximum for solid solution of tantalum in cassiterite.

The existence of these two populations with distinct chemical aspects is well illustrated in Figure 3a. The first one shows columbite-tantalite compositional variation, and probably represents fractionation within the pegmatite; as Martins *et al.* (2011) point out that the Ta:Nb ratio growth follows the chemical fractionation degree. The other population shows samples with the highest amounts of Ta, and the smallest of Fe, evidencing the presence of a phase with higher Sn contents. Samples compositions were also positioned within the columbite quadrilateral diagram (Fig. 3b), in which columbite-(Fe) phase represents 42% of total Nb-tantalates analyzed samples, tantalite-(Fe) 19%, columbite-(Mn) 3%, and ixiolite 36%.

The recognition of ixiolite phase was confirmed through X-ray diffraction analyses (DEMIN lab, Engineering School, Federal University of Minas Gerais). The pattern obtained from the analysis of powder constituted by samples Am21 to Am24 (from Table 1) is shown in Figure 4. However, information about unit cell parameters or a Mössbauer spectroscopy study are important for more precise results, and further analyses are being conducted in order to bring certainty to our results.

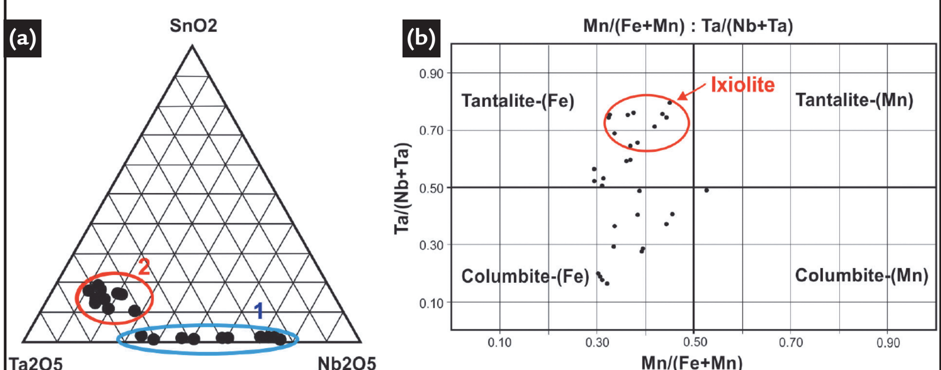

Figure 3
(a) Ternary diagram showing relative contents of Ta_2O_5, Nb_2O_5 and SnO_2. Group 1 represents columbite-tantalite compositions, while group 2 shows a Sn-rich phase, revealed as ixiolite.
(b) Columbite quadrilateral plot, showing the classification of the samples within the solid solution.

Such variation can even be observed in a single grain, reflecting in coloring variation on images obtained by electronic microprobe (Figure 5A, B and C). On the backscattered electrons image, the greater the phase's average atomic number, the lighter it shows on image. As Ta atomic number is greater (73) than that of Nb (41), phases with higher Ta proportions over Nb have a lighter color on images. Analyses of phases with different colorations (grains from Figure 5) are shown on Tables 2, 3 and 4, where lighter parts show higher Ta_2O_5 contents.

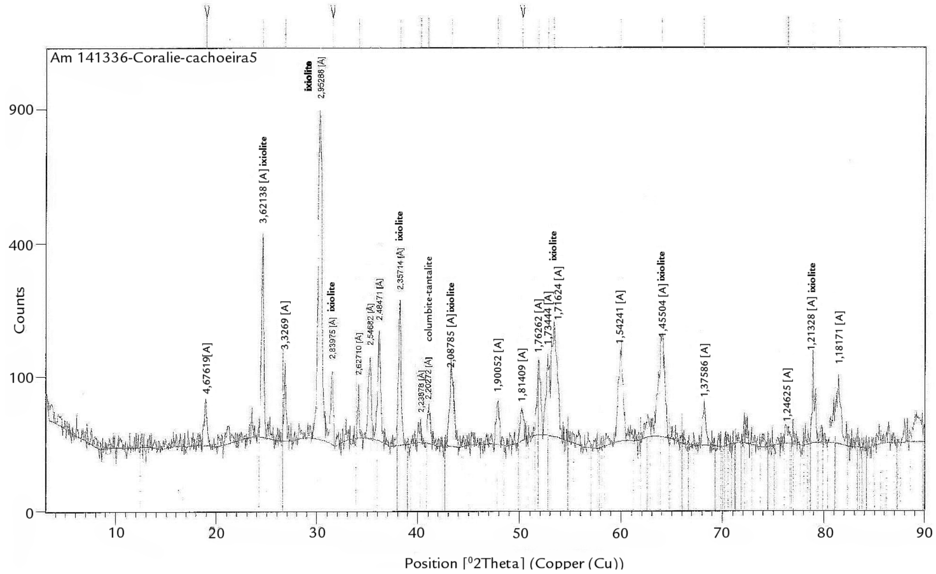

Figure 4
X-ray diffraction
pattern for samples Am21 to Am24.

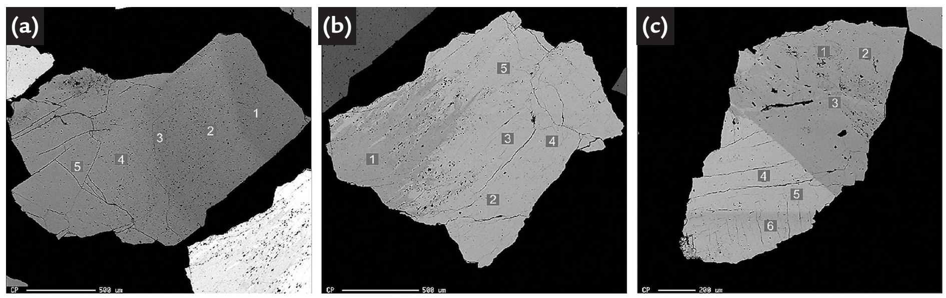

Figure 5
Backscattered
electrons images of Nb-tantalates.
(a). Sample Am3.
(b). Sample Am7.
(c) Sample Am9. All show color
(and chemical) intensity differences.

	Ta_2O_5	Nb_2O_5	FeO	MnO	SnO_2	TiO_2	UO_2	Total	Species
Am3/1-Darker part	20.57	55.42	13.72	6.22	0.89	1.75	0.23	98.81	columbite-(Fe)
↓	21.46	55.25	13.95	5.97	0.72	1.81	0.02	99.17	columbite-(Fe)
	22.25	54.25	14.34	5.81	0.92	1.85	0.10	99.51	columbite-(Fe)
	22.56	54.68	13.32	5.69	0.85	1.71	0.06	98.87	columbite-(Fe)
Am3/5-Lighter part	24.12	53.18	13.76	5.87	0.88	1.95	0.00	99.77	columbite-(Fe)

Table 2
Electronic microprobe analyses
(wt%) of different color intensities in columbite-(Fe) sample Am3 (total iron as FeO).

Analyses of sample Am3 (Figure 5a) exhibited quite similar values, although the lighter part shows a slightly higher Ta content. A color gradation can be observed (lighter to darker, from left to right) and compositional variation is confirmed in analyses from Table 2. Image of sample Am7 (Figure 5b) shows an intergrowth of ixiolite (lighter part) and tantalite-(Fe) (darker part), according to Table 3.

A compositional difference can also be noticed through the color variation on Figure 5c. Table 4 shows analyses of sample Am9 (analysis of point 1 was ignored for been considered erroneous). Points 4, 5 and 6 presented high Sn contents, exactly where Ta_2O_5 value is higher; iron content reduces together with Nb_2O_5.

	Ta_2O_5	Nb_2O_5	FeO	MnO	SnO_2	TiO_2	UO_2	Total	Species
Am7 - Darker part	48.38	29.81	10.73	6.60	1.61	1.89	0.71	99.73	columbite-(Fe)
Am7 - Lighter part	52.62	17.52	8.85	5.12	13.51	1.30	0.07	98.99	ixiolite

Table 3
Electronic microprobe
analyses (wt%) of different phases related to color intensities in Nb-tantalate sample Am7 (total iron as FeO; lighter part analysis as an average of 4 points).

	Ta_2O_5	Nb_2O_5	FeO	MnO	SnO_2	TiO_2	UO_2	Total	Species
Am9 - 2	47.34	30.41	10.95	6.34	2.13	1.94	0.42	99.53	columbite-(Fe)
Am9 - 3	47.81	30.37	10.54	7.11	1.25	2.11	0.17	99.36	columbite-(Fe)
Am9 - 4	53.02	16.59	8.84	5.41	14.21	1.27	0.07	99.41	ixiolite
Am9 - 5	53.48	16.66	9.02	5.64	13.64	1.25	0.07	99.75	ixiolite
Am9 - 6	53.59	17.31	8.77	5.40	12.91	1.32	0.03	99.33	ixiolite

Table 4
Electronic microprobe analyses (wt%) of different color intensities in Nb--tantalate sample Am9 (total iron as FeO).

4. Comparative discussions

For comparison, analyses were carried out in Nb-tantalates from three other rare-element class (REL), lithium subclass (according to Černý and Ercit (2005) classification) deposits in the EBP: Neves, Ipê and Cruzeiro pegmatites (Table 5). The first one is rich on vivid green gemologic spodumene, but spodumene is not reported in the other two. Neves and Cruzeiro pegmatites can be classified as "complex-type" (as well as the Cachoeira pegmatite), while the Ipê is considered a "beryl-type"; thus, it is less evolved than spodumene-bearing pegmatites, and Nb-tantalates from it show lower Ta:Nb ratios. In analyzed samples from these deposits, Ta_2O_5 and Nb_2O_5 contents are highly variable, while SnO_2 values are inexpressive, showing that relatively high contents of this oxide is a typical characteristic of Nb-tantalates from the Cachoeira mine.

	Ta_2O_5	Nb_2O_5	FeO	MnO	SnO_2	TiO_2	UO_2	CaO	Na_2O	MgO	Total	Species
Nev1	62.09	19.29	3.03	13.51	0.39	0.61	0.05	na	na	na	98.82	tantalite-(Mn)
Nev2	16.73	61.77	16.33	3.30	0.75	1.12	0.07	na	na	na	100.18	columbite-(Fe)
Ipê1	17.97	59.02	16.68	4.77	0.24	1.60	0.03	na	na	na	100.89	columbite-(Fe)
Ipê2	18.11	58.84	16.44	4.68	0.24	1.56	0.04	na	na	na	100.49	columbite-(Fe)
Cru1	53.51	30.01	0.06	15.41	0.05	0.03	0.07	0.08	0.08	0.03	99.33	tantalite-(Mn)
Cru2	52.90	30.31	0.17	13.96	0.14	0.22	0.10	0.84	0.60	0.42	99.66	tantalite-(Mn)
Cru3	55.04	29.28	0.02	14.28	0.22	0.31	0.04	0.03	0.01	0.02	99.25	tantalite-(Mn)

Table 5
Electronic microprobe analyses of Nb-tantalates from the Neves (Nev), Ipê and Cruzeiro (Cru) pegmatites from EBP. Data of Cruzeiro pegmatite according to César Mendes (1995) (wt. %; total iron as FeO; na = not analyzed).

On the other hand, Table 6 shows analyses of Nb-tantalates from important Li-rich granitic pegmatites in original and large worldwide known deposits for additional comparisons. Thus, data from the famous Tanco pegmatite, Southeastern Manitoba, Canada (Grice *et al*., 1972) and from the Syväjärvi pegmatite, Kaustinen District, Western Finland (Al-Ani *et al*., 2008) are presented. It is observed that in the "classic" Skögbole and Bradlo deposits, SnO_2 contents vary around 11-12wt%.

In the Tanco pegmatite, Nb-tantalates occur as disseminations in the silicate minerals, and most of columbite-tantalites correspond to tantalite-(Mn), with MnO contents around 14wt% and FeO contents <0.5wt%. During the crystallization of the pegmatite, Nb-tantalates concentrated in late inner zones; Ta:Nb ratio increases in consecutively later zones, while Mn:Fe ratio decreases (Grice *et al*., 1972). These authors state that the physical properties of tantalite and "pseudo-ixiolite" (as it was erroneously designated by them; according to Grice *et al*., 1976) are very similar and these minerals can only be distinguished by X-ray diffraction.

In the Syväjärvi pegmatite, columbite-tantalite compositions are characterized by high Ta:Nb ratios; the Mn and Fe cations have relatively similar concentrations, with Mn:Fe very close to 1. There is a single occurrence of ixiolite within one grain of tantalite with a high concentration of SnO_2 (8.25wt%), related to an alteration product of tantalite-(Fe) in grain Syv1, with a composition close to the wodginite group (Al-Ani *et al*., 2008).

	Ta_2O_5	Nb_2O_5	FeO	MnO	SnO_2	TiO_2	WO_3	ZrO_2	Total	Species
Skö	61.47	10.50	8.08	5.40	12.27	0.38	0.30	0.60	99.00	ixiolite
Bra	63.79	6.12	2.98	9.19	11.38	2.68	1.87	0.20	98.21	ixiolite
Tan1	69.30	16.00	0.40	13.70	0.50	1.50	na	na	101.40	tantalite-(Mn)
Tan2	70.00	17.50	0.40	14.50	0.20	0.20	na	na	102.80	tantalite-(Mn)
Tan3	83.50	4.00	3.30	11.30	0.00	0.20	na	na	102.30	tantalite-(Mn)
Tan4	67.00	16.00	0.50	13.50	0.70	0.30	na	na	98.00	tantalite-(Mn)
Tan5	64.20	21.00	0.20	14.60	0.10	0.40	na	na	100.50	tantalite-(Mn)
Tan6	62.00	18.50	0.40	15.00	0.20	1.20	na	na	97.30	ixiolite
Tan7	64.00	18.00	0.50	15.10	1.80	1.70	na	na	101.10	ixiolite
Tan8	64.00	22.00	0.10	14.40	0.60	0.80	na	na	101.90	ixiolite
Tan9	52.50	27.00	4.00	12.10	1.20	6.20	na	na	103.00	ixiolite
Tan10	64.70	21.50	0.10	14.60	0.60	0.80	na	na	102.30	ixiolite
Tan11	66.20	20.50	0.10	14.40	0.90	0.60	na	na	102.70	ixiolite
Syv1a	63.36	18.42	7.69	8.45	0.14	0.54	na	na	98.59	tantalite-(Mn)
Syv1b	61.73	7.13	6.24	6.08	8.25	0.06	na	na	89.48	ixiolite
Syv2	63.66	15.89	7.56	7.89	0.95	0.42	na	na	96.37	tantalite-(Mn)
Syv3	64.33	17.90	7.46	8.56	0.15	0.63	na	na	99.02	tantalite-(Mn)
Syv4	36.57	45.27	9.98	8.07	0.15	0.61	na	na	100.64	columbite-(Fe)
Syv5	28.51	50.61	9.98	8.98	0.07	0.66	na	na	98.80	columbite-(Fe)
Syv6	61.58	19.98	8.33	7.69	0.21	0.89	na	na	98.68	tantalite -(Fe)

Table 6
Electronic microprobe analyses of ixiolite from initial discoveries from Skögbole (Skö), Kimito Island, Finland (Palache *et al.,* 1944), and Bradlo (Bra), Czech Republic (Nickel *et al.,* 1963). Other analyses from Tanco pegmatite (Tan), Canada (Grice *et al.,* 1972), and Syväjärvi pegmatite (Syv), Finland (Al-Ani *et al.*, 2008) (wt. %; total iron as FeO; na = not analyzed).

It can be observed from Table 6 that all ixiolites present high amounts of Ta_2O_5, as in samples from the studied CBL Cachoeira mine. Tanco ixiolites have very low SnO_2 contents, while Syväjärvi's SnO_2 contents are more close to Cachoeira ones, but still lower.

5. Concluding remarks

Although the EBP is a target region of hundreds of geoscientific studies, several mineralogical issues persist. In this regard, Nb-tantalates constitute an extensive investigation field; there are almost no detailed studies concerning such minerals. Preliminary studies conducted on the Cachoeira mine, which led to the identification of ixiolite associated and intergrown or not with tantalite-(Fe), exemplify that lack of knowledge. It has been the first ixiolite description in the region; this mineral presents chemical aspects much closer to those described in the literature (Palache *et al.*, 1944; Nickel *et al.*, 1963) than those related for the Tanco pegmatite, and is characterized by high tin contents (up to 16wt% SnO_2). Cassiterite presence at the same deposit, with significant contents of Ta_2O_5 (~5wt%), probably indicates, at least partially, the occurrence of exsolution processes.

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