ROSCHERITE-GROUP MINERALS

from Brazil

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INTRODUCTION

The three currently recognized members of the roscherite group are **roscherite** (Mn^{2+} analog), **zanazziite** (Mg analog), and **greifensteinite** (Fe^{2+} analog). These three species are monoclinic but triclinic variations have also been described (Fanfani *et al.* 1977, Leavens *et al.* 1990). Previously reported Brazilian occurrences of roscherite-group minerals include the Sapucaia mine, Lavra do Ênio, Alto Serra Branca, the Córrego Frio pegmatite, the Lavra da Ilha pegmatite, and the Pirineus mine. We report here the following three additional occurrences: the Pomarolli farm, Lavra do Telírio, and São Geraldo do Baixio. We also note the existence of a fourth member of the group, an as-yet undescribed monoclinic **Fe^{3+}-dominant species** with higher refractive indices. The formulas are as follows, including a possible formula for the new species:

Roscherite	$Ca_2Mn_5Be_4(PO_4)_6(OH)_4 \cdot 6H_2O$
Zanazziite	$Ca_2Mg_5Be_4(PO_4)_6(OH)_4 \cdot 6H_2O$
Greifensteinite	$Ca_2Fe^{2+}_5Be_4(PO_4)_6(OH)_4 \cdot 6H_2O$
Fe^{3+}-dominant	$Ca_2Fe^{3+}_{3.33}Be_4(PO_4)_6(OH)_4 \cdot 6H_2O$

THE OCCURRENCES

Alto Serra Branca, Pedra Lavrada, Paraíba

Unanalyzed “roscherite” was reported by Farias and Silva (1986) from the Alto Serra Branca granite pegmatite, 11 km southwest of Pedra Lavrada, Paraíba state, associated with several other phosphates including triphylite, lithiophilite, amblygonite, tavorite, zwieselite, rockbridgeite, huréaulite, phosphosiderite, variscite, cyrilovite and mitridatite. This is also the type locality for arrojadite and serrabrancaite.

Lavra do Criminoso, Água Boa, Minas Gerais

Unanalyzed “roscherite” occurs as green spherules up to 1 mm across, associated with huréaulite, barbosalite and rockbridgeite, at Lavra do Criminoso, a collective name that has been applied to a group of at least a dozen pegmatites, all within a few kilometers of the north bank of the Surubim River near the Fazenda Colonião, municipality of Água Boa, Minas Gerais (Dunn *et al.* 1979). Among collectors the best known specimens from this area are the colorless, tabular, water-clear crystals of beryl.

Lavra da Ilha, Itinga, Minas Gerais

Zanazziite and a triclinic Fe-dominant “roscherite” were described from the Lavra da Ilha pegmatite, on an island in the Jequitinhonha River, approximately 3 km north of Taquaral, Itinga, Minas Gerais state, by Leavens *et al.* (1990). No effort has been made thus far to determine whether the Fe valence state for the triclinic phase is predominantly 2+ or 3+ at this locality. Zanazziite was originally referred to there as “roscherite” (Cassedanne *et al.* 1971, Cassedanne and Cassedanne 1973, Fanfani *et al.* 1975). The associated phosphates include whiteite-(CaFeMg), whiteite-(MnFeMg), eosphorite, amblygonite, rockbridgeite, montgomeryite, wardite, fluorapatite, triphylite, and vivianite (Cassedanne 1987, White 1990). This is the type locality for zanazziite, whiteite-(CaFeMg), and whiteite-(MnFeMg). The occurrence is best known for producing substantial quantities of attractive crystallized rose quartz in the 1970’s.

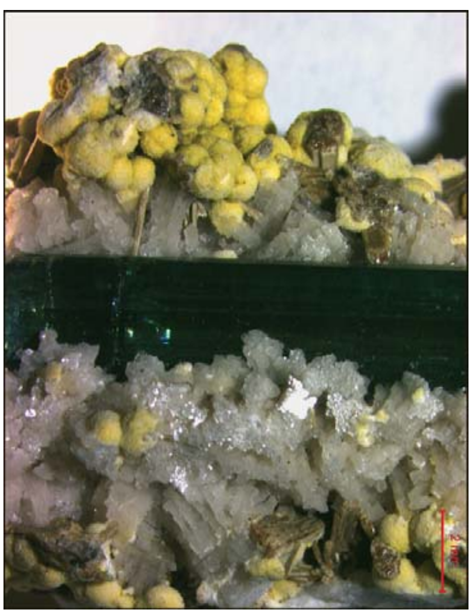

Figure 1. (left) **Yellow zanazziite from Pirineus mine, Itinga, Minas Gerais, associated with eosphorite, tourmaline, albite, quartz, and lepidolite.**

Figure 2. **Yellow zanazziite from Pirineus mine, Itinga, Minas Gerais, associated with eosphorite, tourmaline, albite, quartz, and lepidolite.**

Lavra Pirineus, Itinga, Minas Gerais

At the Pirineus mine, Itinga, zanazziite occurs as pale yellow, radially fibrous spherulites measuring approximately 0.7 mm (Atencio *et al.,* 2000). The diameter of the fibers is approximately 1 to 2 nm. Associated are pale brown prisms of eosphorite, green tourmaline, albite, quartz, and lepidolite (Fig. 1 and 2).

Lavra Sapucaia, Galiléia, Minas Gerais

The Sapucaia mine, in the municipal district of Galiléia, Minas Gerais, has been an important producer of muscovite and beryl, extracted from different zones of an oval-shaped pegmatite (Pecora *et al.* 1950). In the central zone, essentially composed of quartz, perthite, muscovite, and beryl, there is an irregular body of triphylite weighing several hundred tons, which was partially altered by hydrothermal fluids and weathering. An assemblage of rare phosphates resulted, seven of which have been described as new species: frondelite, faheyite, moraesite, "avelinoite" (=cyrilovite), barbosalite, tavorite, and lipscombite.

The other phosphates reported from the Sapucaia mine include fluorapatite, bermanite, childrenite, gordonite, heterosite, huréaulite, leucophosphite, phosphosiderite, montebrasite, saleeite, strengite, variscite, vivianite, dufrenite, ferrisicklerite, lazulite, sabugalite, rockbridgeite, wardite, scorzalite, herderite, phosphuranylite, autunite, jahnsite, arrojadite, johnsomervilleite, augelite, berlinite, strunzite, robertsite, mitridatite, cacoxenite, beraunite, laueite, xenotime-(Y), monazite-(Ce), a mineral similar to kidwellite ("phosphate B", probably meurigite), a metamict phosphate, and some unidentified phosphates. A revised list of the species occurring at this locality was published by Cassedanne and Baptista (1999). A monoclinic Fe^{3+}-dominant roscherite-group specimen was described from the Sapucaia mine, Galiléia, Minas Gerais, under the name "roscherite" (Lindberg 1958, Lindberg & Pecora 1958).

Lavra do Ênio (= Lavra da Boa Vista), Galiléia, Minas Gerais

A monoclinic Fe^{2+}-dominant "roscherite" (= greifensteinite) has been reported from Lavra do Ênio (also known as the Boa Vista farm), Galiléia, Minas Gerais (Cassedanne and Cassedanne 1978, Correia Neves *et al.* 1980, Cassedanne and Cassedanne 1981, Cassedanne 1987). The mine consists of a lenticular, granitic, albitized pegmatite, about 80 meters in length and 10 meters in thickness. The following phosphates were listed: triphylite, sarcopside, heterosite, graftonite, wolfeite, arrojadite, beryllonite, alluaudite, apatite, amblygonite, vivianite, ludlamite, rockbridgeite, childrenite, phosphoferrite, phosphosiderite, herderite, saléeite, phosphuranylite, laueite, cyrilovite, messelite, tavorite, whiteite-(MnFeMg), montebrasite, pharmacosiderite, sicklerite, an unidentified "phosphate A" and a probable vashegyite.

Lavra do Córrego Frio, Linópolis, Divino das Laranjeiras, Minas Gerais

Unanalyzed "roscherite", with very high refractive indices, has been described from the Córrego Frio pegmatite, Linópolis, Divino das Laranjeiras, Minas Gerais (Cassedanne and Cassedanne 1982, Cassedanne 1983). The pegmatite is about 2.5 meters thick at maximum. When discovered it was exposed over a lenght of about 18 meters. The exposure revealed a tabular, parallel quartz core and distinct zonation. A detailed description of the occurrence was given by Cassedanne (1983). The phosphates associated with this "roscherite" are brazilianite, souzalite, scorzalite, beraunite, childrenite, dufrénite, fluorapatite, frondelite, jahnsite, sabugalite, strunzite, and wyllieite. This is the type locality for brazilianite, souzalite and scorzalite; the brazilianite is still considered the world's finest.

Figure 3. **Orange brown zanazziite from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with elongate tabular brown eosphorite crystals, on green brazilianite.**

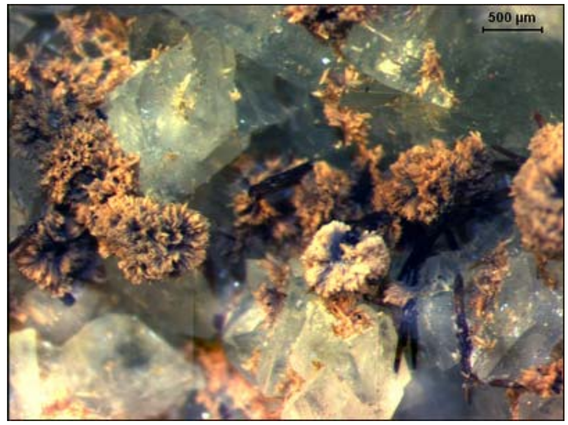

Figure 4. **A close-up of Fig. 3. Orange brown zanazziite from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with elongate tabular brown eosphorite crystals, on green brazilianite.**

Figure 5. **A close-up of Fig. 4. Orange brown zanazziite from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with elongate tabular brown eosphorite crystals, on green brazilianite.**

Figure 6. **Apatite-group mineral from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais.**

Lavra Pomarolli, Linópolis, Divino das Laranjeiras, Minas Gerais

The Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais is also known as the Pamaró, Pamarol, Pamaroli, Pomaroli and Morro do Cruzeiro mine. It lies about 3 km northwest of the João Modesto mine and north of the town of Linópolis. This was a heterogeneous pegmatite striking east to east-southeast and dipping 50° to 70° S. The vein, about 10 meters in width, was exploited via several adits and irregular stopes, yielding amblygonite and tourmaline (Godoy 1945). Minerals found here include quartz, feldspar, mica, schorl, pink and green gem tourmaline, white to green and bluish amblygonite, fluorapatite, beryl, uraninite, a few crystals of tantalite and cassiterite, spectacular eosphorite crystals and brazilianite (Cassedanne, 1983; Atencio *et al.*, 2000).

Figure 7. **White moraesite with brownish green zanazziite and brown eosphorite from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais.**

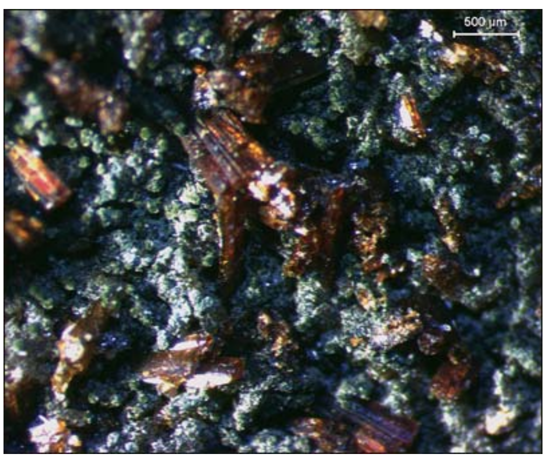

Figure 8. **Brownish green zanazziite from the Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with brown eosphorite.**

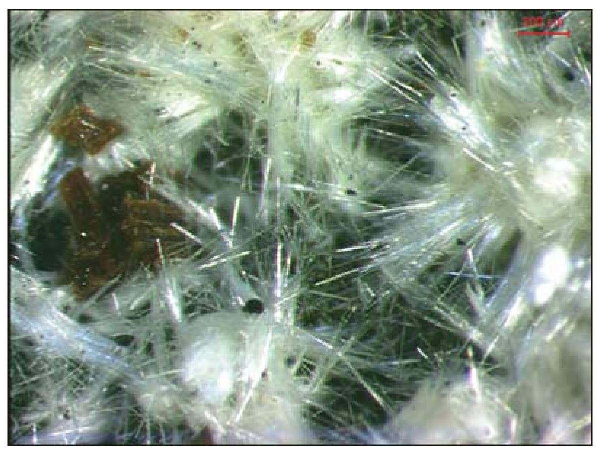

Figure 9. **A close-up of Fig. 7. White moraesite with and brown eosphorite from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais.**

At the Pomarolli farm, roscherite-group minerals occur in three different parageneses: **(1) Orange-brown spherulites** of zanazziite similar to those from the Pirineus mine, associated with elongated, tabular brown eosphorite crystals. This zanazziite is clearly later than eosphorite. Both occur on pale green brazilianite and white apatite fibers (Fig. 3, 4, 5, and 6). **(2) Brownish green fans** of zanazziite intimately associated with brown eosphorite, white beryllonite, and bunches of white moraesite (Fig. 7, 8, and 9). **(3) Brown aggregates** of a monoclinic Fe^{3+}-dominant roscherite-group mineral and minor zanazziite, associated with eosphorite, moraesite and beryllonite (Fig. 10 and 11). The Fe valence state is predominantly 3+ in the Pomarolli farm specimens.

Figure 10. **Brown aggregates of a monoclinic Fe^{3+}-dominant roscherite-group mineral and zanazziite from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with eosphorite, moraesite and beryllonite**

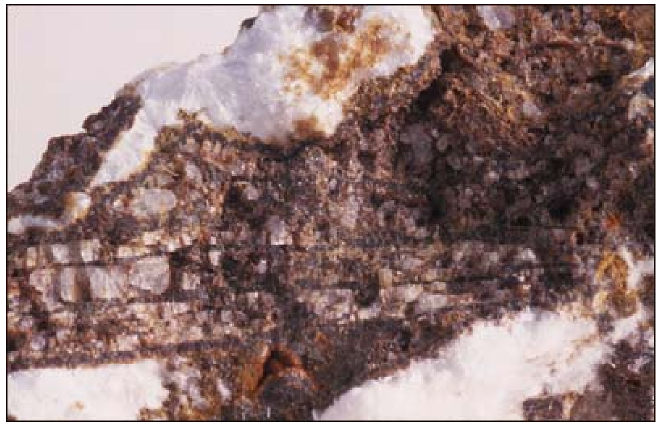

Figure 11. **A close-up of Fig. 10. Brown aggregates of a monoclinic Fe^{3+}-dominant roscherite-group mineral and zanazziite from Pomarolli mine, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with eosphorite, moraesite and beryllonite.**

Figure 12. **Green zanazziite and minor Fe-dominant species from Lavra do Telírio, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with brown eosphorite.**

Figure 13. **A close-up of a brown eosphorite crystal associated with green zanazziite and minor Fe-dominant species from Lavra do Telírio, Linópolis, Divino das Laranjeiras, Minas Gerais, associated with brown eosphorite.**

Lavra do Telírio, Linópolis, Divino das Laranjeiras, Minas Gerais

Lavra do Telírio (Telírio mine), Linópolis, Divino das Laranjeiras, Minas Gerais, is situated south-southwest from the Córrego Frio pegmatite, north-northwest from the town of Linópolis and west of the Mendes Pimentel road. Access is by way of a grassy footpath beginning at the João

Modesto mine. Here a heterogeneous pegmatite striking S30°E and dipping 60°SW was mined for beryl and mica. Phosphates collected there include manganiferous heterosite, ferrisicklerite, brazilianite, fluorapatite, amblygonite, vivianite, frondelite, phosphuranylite, and eosphorite-childrenite (Cassedanne 1983). The locality is most famous for producing substantial quantities of large, very sharp and aesthetic crystals of yellow brazilianite in recent years.

At Lavra do Telírio, zanazziite and a minor Fe-dominant roscherite-group species occur as green aggregates associated with brown eosphorite (Fig. 12 and 13). Crystals show considerable zoning with respect to Fe (greifensteinite and/or a different Fe^{3+}-dominant species) and Mg (zanazziite).

Figure 14. **Brown zanazziite and minor Fe-dominant species from São Geraldo do Baixio, Minas Gerais, associated with white moraesite.**

Figure 15. **Brown zanazziite and minor Fe-dominant species from São Geraldo do Baixio, Minas Gerais, associated with white moraesite**

São Geraldo do Baixio, Minas Gerais

At São Geraldo do Baixio, Minas Gerais, zanazziite with minor amounts of an Fe-dominant roscherite-group species occurs as brown aggregates, associated with white moraesite (Fig. 14 and 15). Unfortunately, the small amount of material available for analysis precluded a determination of the valence state of iron in the Telírio and São Geraldo do Baixio specimens.

OPTICAL DATA

Indices of refraction for some Brazilian roscherite-group minerals are compared with data from the literature in Table 1. Only a mean refractive index value, 1.625 to 1.63, was originally quoted by Slavik (1914) for roscherite from Greifenstein. Additional data obtained by Larsen and Berman (1934) are somewhat superior to the mean data obtained by Slavik (1914) and similar to those obtained by Chukanov *et al.* (2002) for greifensteinite from Greifenstein. Inasmuch as both species occur at the same locality, there is a possibility that the data obtained by Larsen and Berman (1934) are for greifensteinite. No additional optical data are available for roscherite.

Lindberg (1958) recorded higher refractive indices (γ = 1.67 to 1.68) for a variety of “roscherite” samples which occur as fine-grained replacements of frondelite, admixed with beryl, at the Sapucaia mine, Galiléia, Minas Gerais. An Fe^{3+}-dominant species from the Pomaroli farm shows very high refractive indices.

CHEMICAL DATA

Quantitative EDS data were obtained for samples from the Pirineus mine, the Pomaroli farm, São Geraldo do Baixio and Lavra do Telírio (Tables 2 and 3). The chemical data obtained by Lindberg (1958) for the Fe^{3+}-dominant species from the Sapucaia mine are probably inaccurate because they do not agree with the structural formula for roscherite-group minerals.

Some zanazziite analyses from São Geraldo do Baixio are relatively rich in Pb and Mn, and were separated in Table 2 from the normal zanazziite.

The number of cations were calculated for individual EDS point analyses and are represented in Figures 16, 18 and 20. Magnesium plus iron, and magnesium plus manganese show a strongly but not perfectly inverse relationship.

Back-scattered image of roscherite-group minerals from Pomaroli farm, Lavra do Telírio, and São Geraldo do Baixio are shown respectively in Figures 17, 19 and 21.

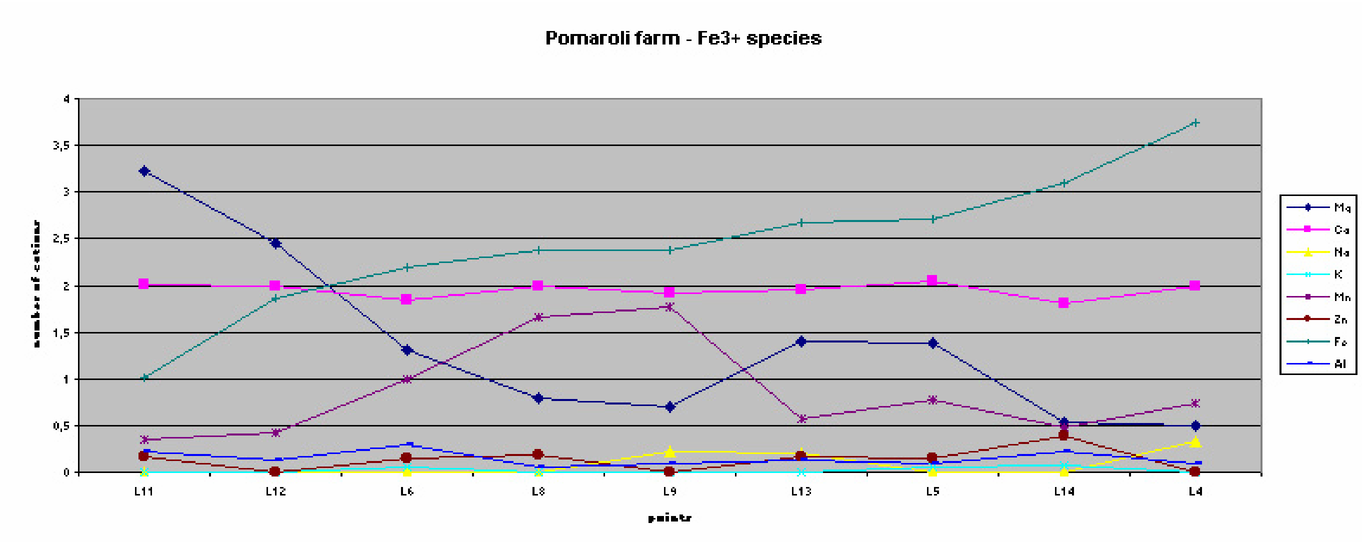

Figure 16. **Number of cations calculated for individual EDS point analyses of roscherite-group minerals from Pomarolli farm.**

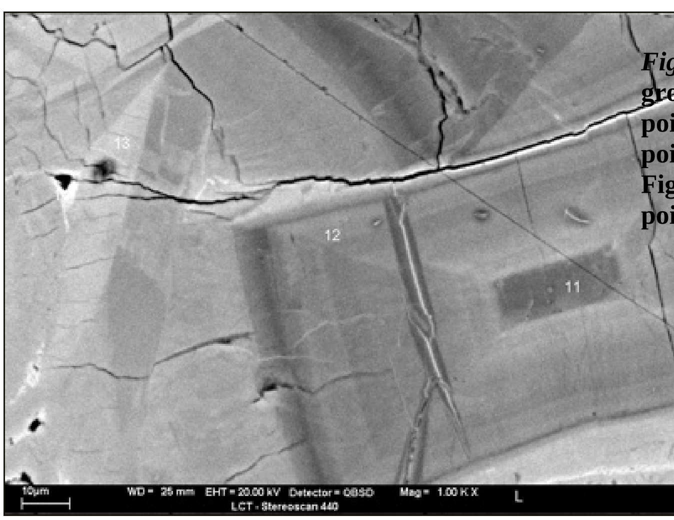

Figure 17. **Back-scattered image of roscherite-group minerals from Pomarolli farm. The points 11, 12, 13 and 14 corresponds to the points L11, L12, L13 and L14, respectively, of Figure 16. Points 11 and 12 are zanazziite, and points 13 and 14 are the Fe^{3+}-dominant species.**

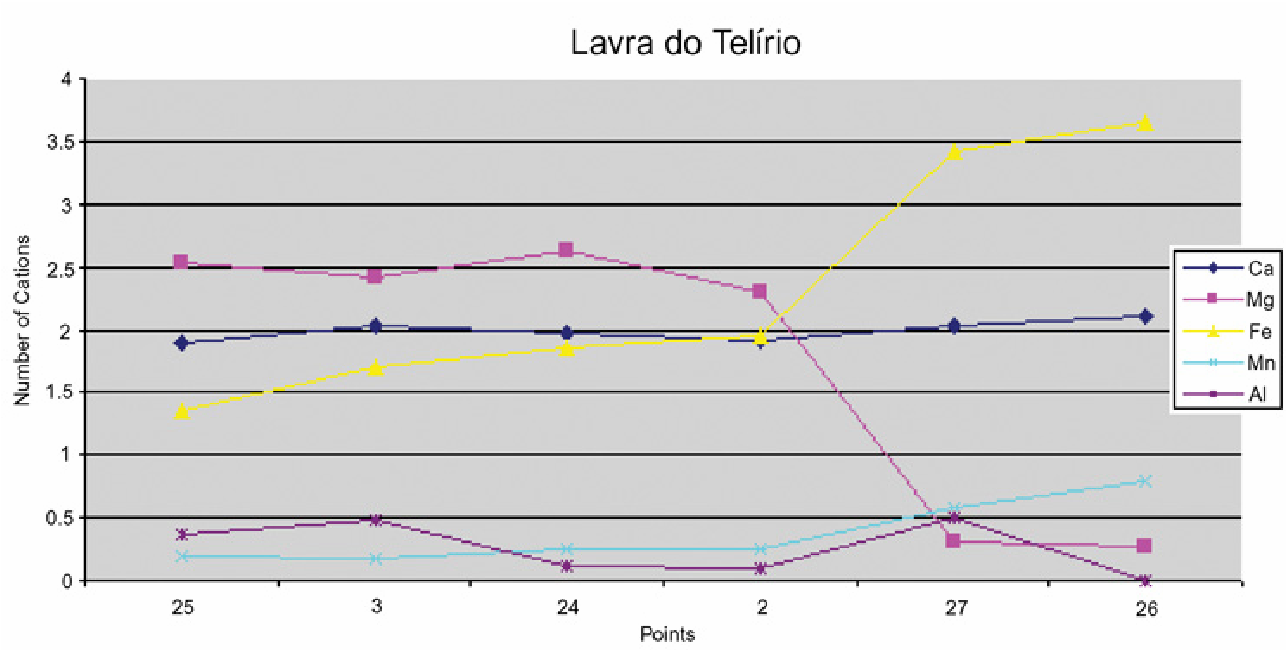

Figure 18. **Number of cations calculated for individual EDS point analyses of roscherite-group minerals from Lavra do Telírio.**

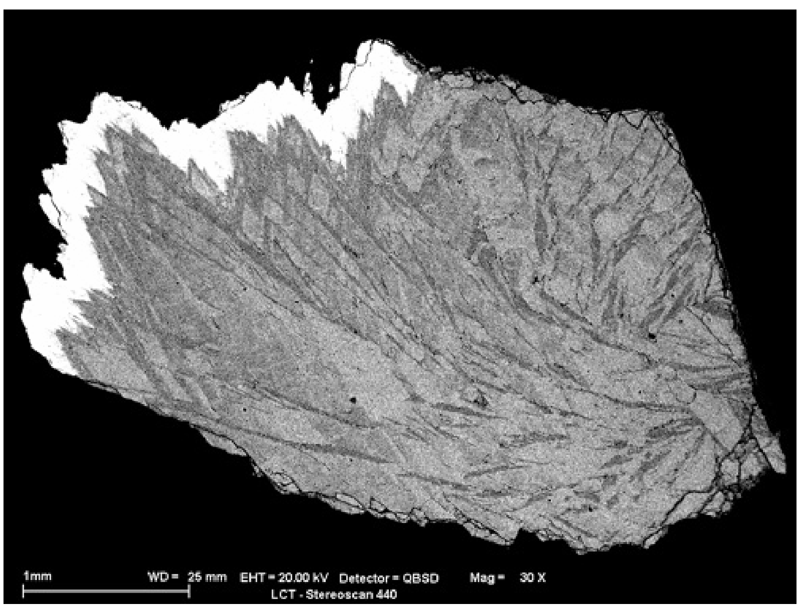

Figure 19. **Back-scattered image of roscherite-group minerals from Lavra do Telírio. The clear part is the Fe-rich species (where points 26 and 27 of Figure 18 were analysed), and the dark part is zanazziite. It should be noted that there is not homogeneous shade neither in the clear (Fe-rich) nor in the dark (Mg-rich) part, due to chemical composition variations.**

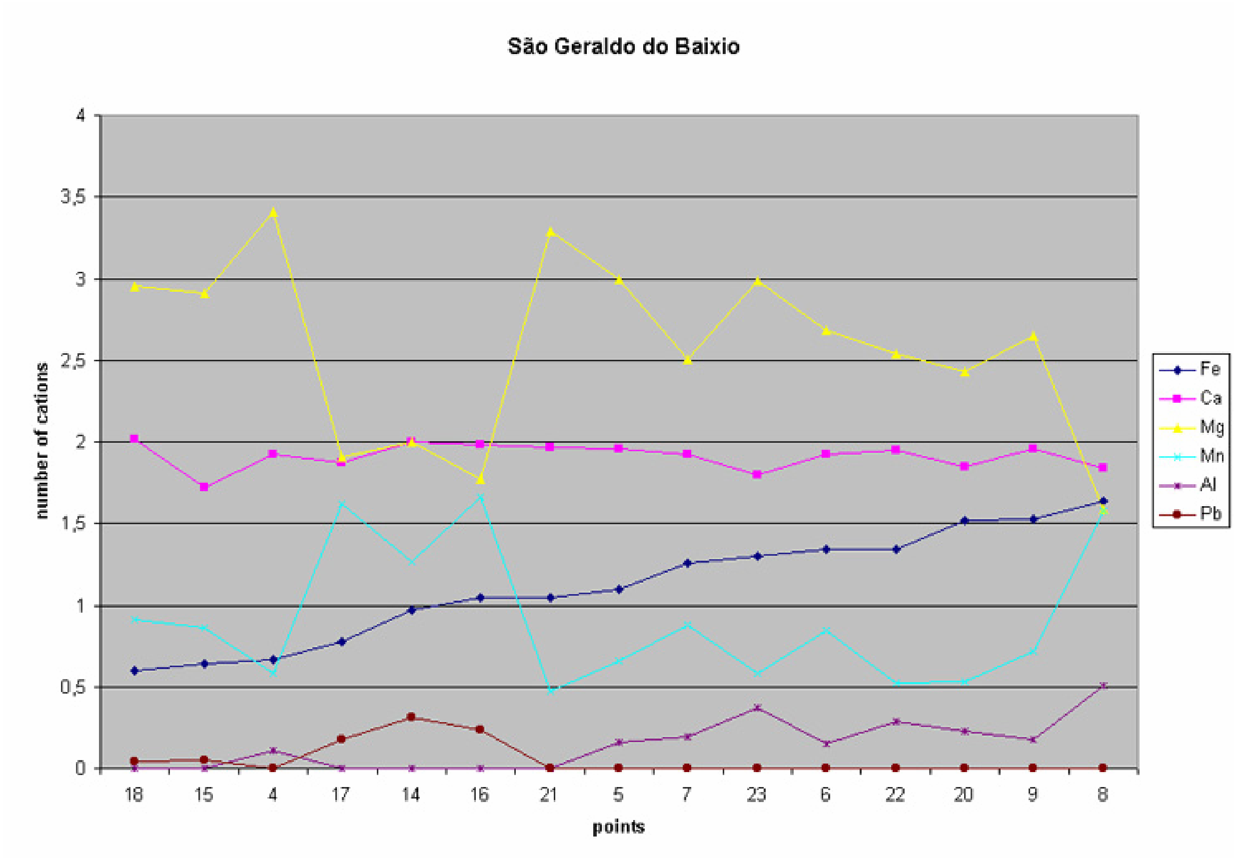

Figure 20. **Number of cations calculated for individual EDS point analyses of roscherite-group minerals from São Geraldo do Baixio.**

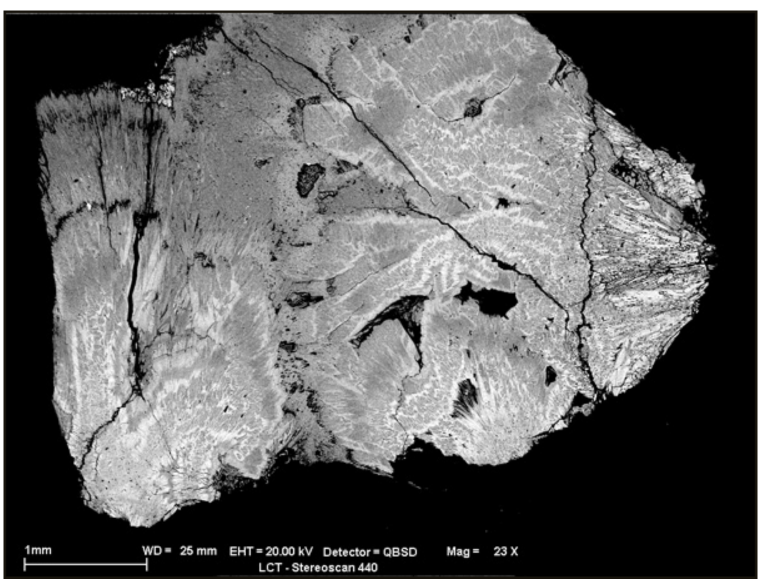

Figure 21. **Back-scattered image of roscherite-group minerals from São Geraldo do Baixio. Iron oxide (white) and moraesite (dark grey) can be seen in the left part from the illustration.**

CRYSTALLOGRAPHY

X-ray powder diffraction data for roscherite-group minerals ftom Brazil are recorded in Table 4. The first X-ray powder diffraction data for roscherite, greifensteinite and the Fe^{3+}-dominant species were obtained by Lindberg (1958). The first X-ray powder diffraction data for zanazziite were recorded by Cassedanne *et al.* (1971). Additional X-ray powder data for greifensteinite are recorded by Cassedanne and Cassedanne (1978), Correia-Neves *et al.* (1980), and Chukanov *et al.* (2002). Additional X-ray powder data for zanazziite were published by Leavens *et al.* (1990). The ICDD card 11-355 labeled "roscherite-*M*" refers to the Fe^{3+}-dominant species (observed pattern) and the card 30-172 also labeled "roscherite-*M*" is for zanazziite (calculated pattern). The observed pattern for zanazziite is recorded in the ICDD card 46-1346. The ICDD card 30-173 labelled "roscherite-*A*" refers to the triclinic Mn-polytype (calculated pattern). The cards 70-1784 and 83-1529 are respectively for the calculated patterns of zanazziite and the triclinic Mn-polytype.

There is some uncertainty about the distribution of the various metallic cations between the two sites, *Me*(1) and *Me*(2), that differentiate the members of the group (Leavens *et al.* 1990) (Table 5). From the crystal structure study of zanazziite, Fanfani *et al.* (1975) suggested that *Me*(1) is occupied mainly by Al, and *Me*(2) by Mg and Fe^{2+}. Leavens *et al.* (1990), on the basis of the same crystal structure determination, concluded that *Me*(1) is occupied instead by Mg and Fe^{2+}, and *Me*(2) by Mg, Fe^{2+}, Mn, Al and Fe^{3+}. In a paper on the crystal structure of a triclinic roscherite, Fanfani *et al.* (1977) concluded that the mineral might contain Fe^{3+}, Mn^{3+} and Al in *Me*(1) (but the valence state was not investigated), and Mn^{2+} and Mg in *Me*(2). From the crystal structure determination of greifensteinite, Rastsvetaeva *et al.* (2002) assigned Mn^{2+} to *Me*(1), and Fe^{2+}, Fe^{3+}, Mg and Al to *Me*(2). Considering this general lack of agreement on site occupancy it might be more practical, for the time being at least, to utilize the contents of both sites jointly in order to establish definitions for the various species.

CONCLUSIONS

A new Fe^{3+}-dominant roscherite-group species exists, in addition to the three currently-accepted roscherite-group minerals—roscherite, zanazziite and greifensteinite. In order to fully clarify relationships in the group, the complete characterization of the Fe^{3+}-dominant species will be necessary. Additional data on these species, including optical data for roscherite, will need to be determined. Several of the Brazilian occurrences of roscherite-group minerals will require more detailed examination.

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Table 1. **Optical properties for roscherite-group minerals.**

	1	2	3	4	5	6	7	8	9	10	11
Optical sign	(-)	(-)	(-)	(+)	(+)	(+) or (-)	(+)	(+)	(+)	(+)	(+)
α	1.624	1.624(2)	1.628	1.636	1.666	1,670 to 1.680	1.606(2)	1.608(3)	1.608(3)	1.605(3)	1.612(3)
β	1.639	1.634(2)	1.644	1.641	1.672	1.680 to 1.700	1.610(2)	1.610(3)	1.612(3)	1.609(3)	1.618(3)
γ	1.643	1.638(2)	1.650	1.651	1.682	1.695 to 1.705	1.620(2)	1.620(3)	1.624(3)	1.617(3)	1.629(3)
$2V_z$ obs. (°)		80(10)				60 to 90	72	70(10)	70(10)	70(10)	70(10)
$2V_z$ calc. (°)	54.2	64(20)	62.5	70.9	75.9		65.0	48.4	60.4	70.8	73.3
Pleochroism α	**Yellow to olive-green**	**Light blue-green**									
β	**Yellow-brown, slightly greenish**	**Light green**									
γ	**Chestnut-brown**	**Brown to green**									

1. Roscherite (?), Greifenstein, near Ehrenfriedersdorf, Saxony, Germany (Larsen & Berman 1934).
2. Greifensteinite, Greifenstein, near Ehrenfriedersdorf, Saxony, Germany (Chukanov *et al.,* 2002).
3. ? Fe, Clitters United mine, Gunnislake, Cornwall, England. UK (Clark *et al.* 1983).
4. **Fe^{3+}-dominant species**, Sapucaia pegmatite, Galiléia, Minas Gerais, Brazil (Lindberg 1958).
5. ?, Córrego Frio pegmatite, Linópolis, Divino das Laranjeiras, Minas Gerais, Brazil (Cassedanne & Cassedanne 1982).
6. **Fe^{3+}-dominant species**, Lavra Pomarolli, Linópolis, Divino das Laranjeiras, Minas Gerais, Brazil (this paper).
7. Zanazziite, Lavra da Ilha pegmatite, Itinga, Minas Gerais, Brazil (Leavens *et al.* 1990).
8. Zanazziite, Pirineus mine, Itinga, Minas Gerais, Brazil (Atencio *ei al.* 2000).
9. Zanazziite, Lavra do Telírio, Linópolis, Divino das Laranjeiras, Minas Gerais, Brazil (this paper).
10. Zanazziite. São Geraldo do Baixio, Minas Gerais, Brazil (crystal nucleus, this paper).
11. Zanazziite, São Geraldo do Baixio, Minas Gerais, Brazil (crystal border, this paper).

Table 2. **Chemical data for zanazziite (in weight %).**

	1	2	3	4	4 (range)	5	5 (range)	6	6 (range)	7	7 (range)	8	8 (range)
K_2O													
Na_2O													
BeO	9.81	n.a.	n.a.	9.30		9.13		8.90		9.50		9.03	
CaO	10.65	10.11	10.05	9.87	(9.51-10.19)	9.82	(8.66-10.40)	9.53	(9.11-10.07)	10.39	(10.09-10.83)	10.17	(10.03-10.30)
MgO	11.66	9.85	8.80	10.79	(10.45-11.10)	10.44	(8.86-13.39)	8.35	(5.95-11.35)	9.45	(8.82-10.00)	10.37	(8.85-11.88)
MnO	1.77	2.26	3.66	2.38	(2.05-2.58)	4.17	(3.03-5.79)	7.85	(5.77-10.06)	1.48	(1.36-1.71)	2.53	(2.30-2.75)
PbO								3.21	(0.81-6.13)				
ZnO												0.63	(0.00-1.25)
FeO	9.63	8.91*	9.40	9.77*	(9.41-10.19)	8.06*	(4.64-9.88)	5.13*	(3.81-6.31)	11.77*	(9.30-13.39)	3.61	(2.59-4.63)
Fe_2O_3	0.76		0.80									6.37	(4.57-8.17)
Al_2O_3	1.54	1.03	1.45	1.33	(1.05-1.48)	0.87	(0.00-1.63)	0.00	(0.00-0.00)	1.29	(0.45-1.72)	0.80	(0.54-1.06)
P_2O_5	39.27	38.36	38.30	39.58	(38.56-40.30)	38.89	(36.52-39.62)	37.87	(35.45-41.21)	40.42	(40.02-40.79)	38.50	(38.04-38.96)
SiO_2	0.36		0.22										
H_2O	13.32	n.a.	n.a.	13.41		13.02		11.93		13.30		12.24	
total	98.77			96.43		94.40		92.77		97.60		94.25	

NOTE: The standards used are the following: Orthoclase for K, jadeite for Na, wollastonite for Ca, MgO for Mg, PbF_2 for Pb, GaP for P, quartz for Si, and pure Mn, Zn, Fe, and Al. The BeO and H_2O contents were calculated for ideal 4 Be atoms and 6 H_2O molecules in the formula. *All Fe calculated as FeO.

1 to 3. Zanazziite, Lavra da Ilha, Itinga, Minas Gerais, Brazil (Leavens *et al.* 1990).
4. Zanazziite, Lavra dos Pirineus, Itinga, Minas Gerais, Brazil (this paper, mean of 3 analyses).
5. Zanazziite, São Geraldo do Baixio, Minas Gerais, Brazil (this paper, mean of 9 analyses).
6. Pb- and Mn-rich zanazziite, São Geraldo do Baixio, Minas Gerais, Brazil (this paper, mean of 5 analyses).
7. Zanazziite, Lavra do Telírio, Linópolis, Divino das Laranjeiras, Minas Gerais, Brazil (this paper, mean of 4 analyses).
8. Zanazziite, Lavra Pomarolli, Linópolis, Divino das Laranjeiras, Minas Gerais, Brazil (this paper, mean of 2 analyses).

Table 3. Chemical data for greifensteinite and the Fe^{3+}-dominant species (wt. %).

	1	1 (range)	2	3	4	5	6	7	7 (range)	8	8 (range)	9	10
K_2O								0.12	(0.00-0.36)				
Na_2O								0.29	(0.00-0.87)				
BeO	9.24		13.01	12.60	8.49	10.05	12.71	8.64		8.59		8.86	9.18**
CaO	9.98	(9.89-10.09)	10.11	10.40	9.45	10.76	7.68	9.39	(8.98-9.78)	9.93	(9.74-10.11)	9.14	10.63
MgO	0.34	(0.13-0.69)	-	6.90	-	-	-	3.29	(1.66-4.95)	0.98	(0.92-1.04)	5.66	6.99
MnO	5.56	(4.51-6.39)	8.66	1.81	0.91	0.50	10.14	6.05	(3.12-10.48)	4.16	(3.52-4.79)	9.93	1.32
PbO													
ZnO								1.06	(0.00-2.83)				
FeO	22.42	(22.26-22.63)	16.49	15.74	27.04*	30.40*	6.32	6.58	(5.42-8.77)	21.83*	(21.19-22.47)	10.42*	20.52*
Fe_2O_3			0.90				13.49	11.62	(9.58-15.47)				
Al_2O_3	1.05	(0.89-1.35)		2.00	0.68			0.65	(0.28-1.35)	1.12	(0.00-2.23)	2.30	0.47
P_2O_5	38.36	(37.73-38.82)	38.74	37.50	37.45	34.12	37.98	36.44	(35.61-38.98)	36.56	(36.48-36.64)	37.70	39.09
SiO_2								0.33	(0.00-1.81)				
H_2O	13.6		12.09	13.06	11.95	11.80	11.68	11.09		12.30		12.11	12.56**
total	100.55		100.00	100.01	95.97	98.33	100.00	95.55		95.47		96.12	100.76

NOTE: The standards used are the following: Orthoclase for K, jadeite for Na, wollastonite for Ca, MgO for Mg, PbF_2 for Pb, GaP for P, quartz for Si, and pure Mn, Zn, Fe, and Al. The BeO and H_2O contents were calculated for ideal 4 Be atoms and 6 H_2O molecules in the formula. For the Fe^{3+}-dominant species from Lavra Pomaroli, Fe^{2+} and Fe^{3+} were quantified by the method developed by Andrade *et al.* (2002).

1. Greifensteinite, Greifenstein, near Ehrenfriedersdorf, Saxony, Germany (Chukanov *et al.*, 2002)
2. Greifensteinite, Nevel Quarry, Newry, Oxford Co., Maine, USA (Lindberg 1958)
3. Greifensteinite, Lavra Boa Vista (=Lavra do Ênio), Galiléia, Minas Gerais, Brazil (Correia Neves *et al.* 1980).
4 and 5. (?Fe^{2+} or $^{3+}$), Clitters United mine, Gunnislake, Cornwall, England. UK (Clark *et al.* 1983).
6. **Fe3+-dominant species,** Lavra Sapucaia, Galiléia, Minas Gerais, Brazil (Lindberg 1958).
7. **Fe3+-dominant species**, Lavra Pomarolli, Linópolis, Divino das Laranjeiras, Minas Gerais, Brazil (this paper, mean of 7 analyses).
8. (?Fe^{2+} or $^{3+}$), Lavra do Telírio, Linópolis, Divino das Laranjeiras, Minas Gerais, Brazil (this paper, mean of 2 analyses).
9. (?Fe^{2+} or $^{3+}$), São Geraldo do Baixio, Minas Gerais, Brazil (this paper, 1 analysis).
10. Triclinic (?Fe^{2+} or $^{3+}$), Lavra da Ilha, Itinga, Minas Gerais, Brazil (Leavens *et al.* 1990).

*all Fe calculated as FeO.

**here calculated for ideal 4Be and $6H_2O$.

Table 4 – X-ray powder diffraction data for roscherite-group minerals from Brazil.

1					2		3		4		5		6				
d(Å)	I(%)	h	k	l	d(Å)	I(%)	d(Å)	I(%)	d(Å)	I(%)	d(Å)	I(%)	d(Å)	I(%)	h	k	l
9.50	90	1	1	0	9.650	36	9.478	38	9.454	48	9.723	32	9.58	90	-1	1	0
							7.937	4					7.95	15	2	0	0
5.91	100	0	2	0	5.999	38	5.944	100	5.908	100	5.985	100	5.96	100	0	2	0
					5.289	8			5.385	1	5.587	8	5.61	10	-1	1	1
4.82	20	3	1	0	4.848	19	4.819	14	4.794	12	4.843	19	4.84	40	3	1	0
4.43	10	0	2	1	4.428	5	4.377	5	4.415	2	4.434	6	4.42	15	0	2	1
					3.871	2	3.988	3	3.946	10	4.001	5	3.97	5	-2	2	1
							3.739	6					3.76	5	3	1	1
3.35	20	1	3	-1	3.353	12	3.373	11	3.314	7	3.355	15	3.37	15	-1	3	1
					3.306	18	3.318	10			3.314	7	3.30	10	1	3	1
3.16	70	3	3	0	3.169	30	3.160	36	3.151	32	3.180	38	3.18	70	3	3	0
													3.15	5	-2	0	2
3.05	50	5	1	0	3.046	10	3.067	10	3.057	11	3.073	24	3.08	20	5	1	0
2.945	20	0	4	0	2.953	5	2.967	16	2.965	9	2.977	12	2.975	20	0	4	0
									2.883	6	2.894	8	2.909	5	-3	3	1
2852	10	4	2	1			2.868	8									
							2.840	8	2.833	6	2.826	11	2.839	10	-3	1	2
2.766	50	2	4	0			2.776	38	2.764	63	2.792	48	2.796	50	2	4	0
							2.689	4					2.715	5	0	4	1
2.632	40	6	0	0	2.642	28	2.632	18	2.629	14	2.648	26	2.652	40	6	0	0
					2.526	5	2.515	5	2.535	1	2.530	8	2.547	5	2	4	1
					2.428	2	2.429	5	2.402	5	2.430	7	2.428	15	-4	2	2
					2.414	11	2.401	8					2.386	5	-4	4	0
							2.341	16	2.342	9	2.367	7	2.365	10	1	5	0
							2.270	4	2.247	5			2.280	5	-4	4	1
2.208	40	7	1	0	2.223	14			2.200	5	2.223	13	2.235	20	7	1	0
2.208	40	1	5	-1			2.116	10			2.208	40					
2.159	20	3	5	0			2.191	9	2.154	6	2.169	8	2.176	15	3	5	0
2.159	20	-7	1	1							2.139	3	2.060	10	7	1	1
2.031	20	-2	2	3			2.043	3	2.039	4	2.042	7	2.040	20	-2	2	3
2.031	20	3	5	1													
													1.992	20	0	6	0
1.974	20	8	0	0	1.981	6	1.972	10	1.971	8	1.979	13					
1.974	20	0	6	0													
													1.934	15	-6	4	1
1.917	20	-7	3	1	1.920	4	1.915	6	1.907	4	1.924	4					
							1.796	4					1.780	15	4	6	0

1.769	20	7	1	2							1.768	4					
					1.759	3	1.763	6	1.759	7			1.756	5	-7	3	2
1.746	10	-2	4	3			1.732	3			1.750	7					
											1.702	6	1.704	5	0	6	2
1.692	10	2	4	3	1.689	7	1.681	5									
							1.649	4					1.656	30	8	4	0
1.642	50	9	1	1	1.644	6	1.641	13	1.636	11	1.646	9					
													1.619	5	-1	5	3
													1.533	5	2	2	4
1.517	10	3	1	4	1.512	4			1.517	5							
1.490	10	5	7	0	1.492	3			1.511	3	1.505	2					
1.461	10	-3	7	2					1.467	5	1.469	4					
											1.460	2	1.442	5	-10	2	2
1.430	10	3	7	2													
													1.411	5	-4	6	3

1. Zanazziite, Lavra da Ilha, Itinga, Minas Gerais, Brazil (Leavens *et al.* 1990, ICDD card 46-1346).
2. Zanazziite, São Geraldo do Baixio, Minas Gerais, Brazil (this paper).
3. Zanazziite, Lavra do Telírio, Linópolis. Divino das Laranjeiras, Minas Gerais. Brazil (this paper).
4. Zanazziite, Pomarolli farm, Linópolis, Divino das Laranjeiras, Minas Gerais. Brazil (this paper).
5. Fe^{3+}-dominant species, Pomarolli farm, Linópolis, Divino das Laranjeiras, Minas Gerais. Brazil (this paper).
6. Fe^{3+}-dominant species, Sapucaia pegmatite, Galiléia, Minas Gerais. Brazil (Lindberg 1958, ICDD card 11-355).

Table 5 – Distribution of the various cations between the *Me*(1) and *Me*(2) sites for roscherite-group minerals.

Mineral	*Me*(1)	*Me*(2)	Authors
zanazziite	Al	Mg, Fe^{2+}.	Fanfani *et al.* (1975)
zanazziite	Mg, Fe^{2+},	Mg, Fe^{2+}, Mn, Al, Fe^{3+}	Leavens *et al.* (1990)
triclinic roscherite	Fe^{3+}, Mn^{3+}, Al	Mn^{2+}, Mg	Fanfani *et al.* (1977)
greifensteinite	Mn^{2+}	Fe^{2+}, Fe^{3+}, Mg, Al	Rastsvetaeva *et al.* (2002)