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Nigerite in the tin–tantalum pegmatites of Amapá, Brazil

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SUMMARY. The location and some characteristics of nine veins containing nigerite are reported. These veins are part of the province of tin–tantalum veins of central Amapá. They are intrusive in andalusite schist and commonly consist of pegmatite in the centre and of quartz–mica rock at the margins. The nigerite can occur in the pegmatite as well as in the quartz–mica rock; its presence in a sample of quartz–sillimanite rock is also mentioned. In both pegmatite and quartz–mica rock, the common associated translucent heavy minerals are cassiterite, tourmaline, chrysoberyl, and occasionally andalusite, sillimanite, and garnet. Associated minerals in the quartz–sillimanite rock are cassiterite and chrysoberyl. Nigerite and cassiterite commonly occur together but are not found in the presence of gahnite. A possible explanation for this is given.

The nigerite of Amapá occurs as thin hexagonal plates, transparent and golden brown, amber-yellow or colourless, with diameters from microscopic up to a few millimetres. The sizes and the optical sign of this nigerite are the same as those of Nigeria and of Siberia, whereas Portuguese nigerite occurs in very fine grains and is mostly optically negative. The existence of alluvial nigerite is reported.

IN 1968, during a prospecting programme for cassiterite in the central part of Amapá Territory, Brazil, samples of vein material were panned and later concentrated in bromoform. The microscopic study of the translucent heavy minerals revealed in several samples the presence of clear and brownish platy grains, having a hexagonal habit. Dr. C. V. Dutra, of Geologia e Sondagens Ltda., Belo Horizonte, identified it as nigerite. This identification was confirmed by its crystal habit and its optical properties. In a preliminary report on five veins containing nigerite (Kloosterman, 1969*b*) there was also described a sample of uncertain origin consisting of quartz–sillimanite rock containing nigerite. More field-work was done, and a second preliminary note was published (Kloosterman, 1972), giving additional data on nigerite and on its mode of occurrence. It was found in four other veins, bringing the known total in Amapá to nine veins with nigerite. Data on alluvial nigerite were also given.

The present paper includes the data of both preliminary reports (written in Portuguese) as well as more mineralogical properties. The Amapá nigerite is compared with that of the other known occurrences, and the chemical conditions for its formation are discussed. As nigerite is easily identifiable by its habit the writer hopes that the included photomicrographs will contribute to the discovery of new occurrences.

Special thanks go to Prof. C. V. Dutra, Belo Horizonte, who identified the nigerite and made a spectrochemical analysis. I am also grateful to Dr. R. D. Schuiling of Utrecht University, Holland, who helped with the identification of minerals, and to Prof. O. Leonardos Jr., who placed at my disposal the facilities of the Escola de Geologia of Rio de Janeiro.

Previous literature. Nigerite was first discovered in the tin–tantalum veins of central Nigeria, in 1944, by Jacobson and Webb, who described its mode of occurrence (1947). A chemical analysis and crystallographic description were given by Bannister, Hey, and Stadler (1947), who determined the chemical composition to be (Zn, Mg, Fe″)(Sn, Zn)$_2$(Al, Fe‴)$_{12}$O$_{22}$(OH)$_2$. Ginzburg *et al.* (1961) describe nigerite as a common mineral in certain pegmatites of Eastern Siberia (without specifying the place). It is not mentioned explicitly whether the Siberian veins contain cassiterite.

Mayer (1965) found nigerite as a common accessory in the pegmatites of Seixoso-Macieira, between Felgueiras and Amarante in northern Portugal. There, discordant veins are found, from 5 to 12 m thick, intrusive in hornfels in the cordierite–andalusite zone around the Amarante granite. It is not mentioned whether andalusite occurs in the immediately adjacent rock. The veins consist of megacrysts of potash feldspar in a matrix of albite, muscovite, and quartz, with the albite predominant. Other minerals are tourmaline, cassiterite, zircon, andalusite, sillimanite, columbotantalite, gahnite, nigerite, chrysoberyl, and several phosphates. The nigerite is from 0·1 up to 1 mm in size, with very lustrous basal faces. Optically negative crystals are predominant, but positive ones also occur, and occasionally there exist alternating zones in one crystal; *n* 1·80–1·81.

Mayer also reports an occurrence of nigerite not in veins but in a granitic rock. He found, on the contact of a small (0·3 km) body of tourmaline-bearing granite, a rock containing many small rose-coloured andalusite crystals. Other minerals in the granite are plagioclase, muscovite, quartz, sillimanite, and biotite. Accessories are nigerite and an unidentified mineral. The nigerite in this rock is similar to that of the pegmatites, and occurs as inclusions in the muscovite replacing andalusite, in the andalusite near muscovite, and along cracks in the andalusite. The mineral seems to have been formed by reaction of the andalusite with Sn- and Zn-bearing solutions.

Van Tassel (1965) describes optically negative nigerite, with a high titanium content, from a cassiterite-bearing pegmatite found near Felgueiras, obviously forming part of the same pegmatite field Mayer describes. The mineral occurs in aggregates near the white mica, associated with nests of phosphates such as lithiophyllite, apatite, and vivianite. The hexagonal plates are very small, never more than 0·25 mm in diameter.

An occurrence of nigerite in riebeckite-gneiss is noted by Macdonald and Saunders (1973) from La Guia, Vigo, in NW. Spain. The nigerite there occurs as red, hexagonal tablets in association with quartz, albite, microcline, riebeckite, lepidomelane, aegirine, zircon, and fluorite.

Kloosterman (1974) found traces of nigerite in quartz–cassiterite veins in the Upper Candeias area, Rondônia, Brazil. These veins are associated with an intrusive granite complex and constitute an exception: in other complexes belonging to the same province of subvolcanic granites, the mineralization is characterized by a cassiterite–

topaz paragenesis. The quartz veins of the Upper Candeias area carry green mica, cassiterite, phenakite, and nigerite.

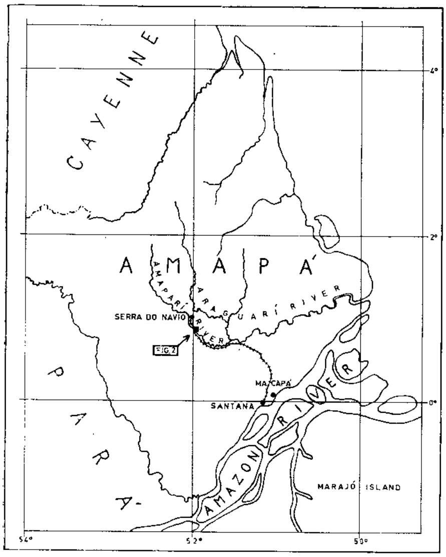
In Amapá, nigerite was discovered in 1956 in quartz–mica rock of unspecified origin. De Morães (1959), who brought the sample from the city of Macapá to southern Brazil, gives the Araguarí–Amaparí region as its origin, in the central part of Amapá Territory. Távora identified the mineral with X-rays, and Guimarães and Teixeira da Costa (1957) gave a description of the sample: a medium-grained greisen of gneissoid texture, with 22 % cassiterite up to 8 mm in size, sodic mica (paragonite), quartz, and as accessory minerals chrysoberyl and nigerite. The nigerite occurs associated with cassiterite and mica. Baptista and Baptista (1968) published a crystallographic description, and also a chemical analysis by Dutra. This sample undoubtedly originated in the same province of tin–tantalum veins of central Amapá (Kloosterman, 1969*a*) where the present author found nigerite in 1968. It is the only province known in Amapá and veins of quartz–mica rock with oriented mica are very common there. It should be noted that the author did not find a rock fitting the above description in the Jornal area so that the exact origin remains unknown.

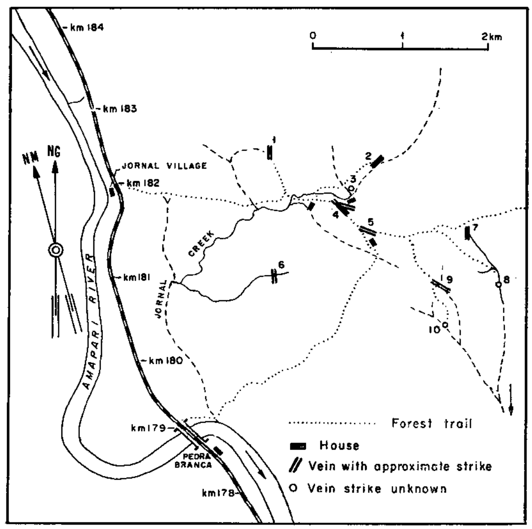
The veins with nigerite

Nigerite was found in nine veins out of a total of ten known veins in the area of Igarapé Jornal, situated about 10 km south-east of the Serra do Navio, or 3 km east of Jornal Village at km 182 on the railroad leading from the Santana harbour to the manganese deposits of the Serra do Navio. The area in which the veins occur measures about 2×4 km (fig. 2). Only in the Maruim vein was hard rock found *in situ*. Data for the other veins are based on rock fragments and on the heavy-mineral concentrates of altered material. The habit of the nigerite crystals is different in each vein. Below follow descriptions of five veins; data on heavy mineral content are summarized in Table II. The gravel under the flats of all creeks in this area (Jornal and Maragují creeks and their tributaries) carries large quantities of coarse andalusite, in its variety chiastolite, with local concentrations of garnet.

Maruim vein (fig. 2, 2). This vein, with approximate strike 225° and dipping 40° NW., consists of both quartz–mica rock and pegmatite. Fractured quartz with coarse muscovite occurring in the cracks where the rock grades into quartz–mica rock is exposed over a 5-m stretch in a prospecting trench. The concentrate of the quartz–mica rock carries 35 % nigerite, the remainder being tourmaline, sillimanite, chrysoberyl, and some opaques, half of which is columbotantalite. Accessories are zircon, andalusite, and cassiterite. The nigerite occurs associated with muscovite, in clusters of separate crystals. The crystals, thin hexagonal plates, frequently have diameters of 1·5 and 2 mm, with an observed maximum of 3·2×3·0×0·2 mm.

On the southern side of the trench and only some 6 m away is an abandoned prospecting pit in the creekflat of Jornal creek, which has exposed quartz–mica rock on the hillside and some pegmatite close to water level. The pegmatite consists of mica and coarse (up to 5 and 10 cm) quartz in a matrix of kaolin. Clusters of nigerite can be found on the sides of the quartz, together with mica and black amorphous minerals. The heavy concentrate carries chrysoberyl, nigerite, and some andalusite, and traces of cassiterite. The nigerite crystals of the pegmatite are smaller than those found in the quartz–mica rock; common diameters are from 0·2 to 0·5 mm, with an observed maximum of 1·2 mm (fig. 3). The nigerite of Maruim vein varies under the microscope in colour from reddish brown (reminding one of the colour of staurolite) to amber yellow. Even in very thin flakes the colour is distinct.



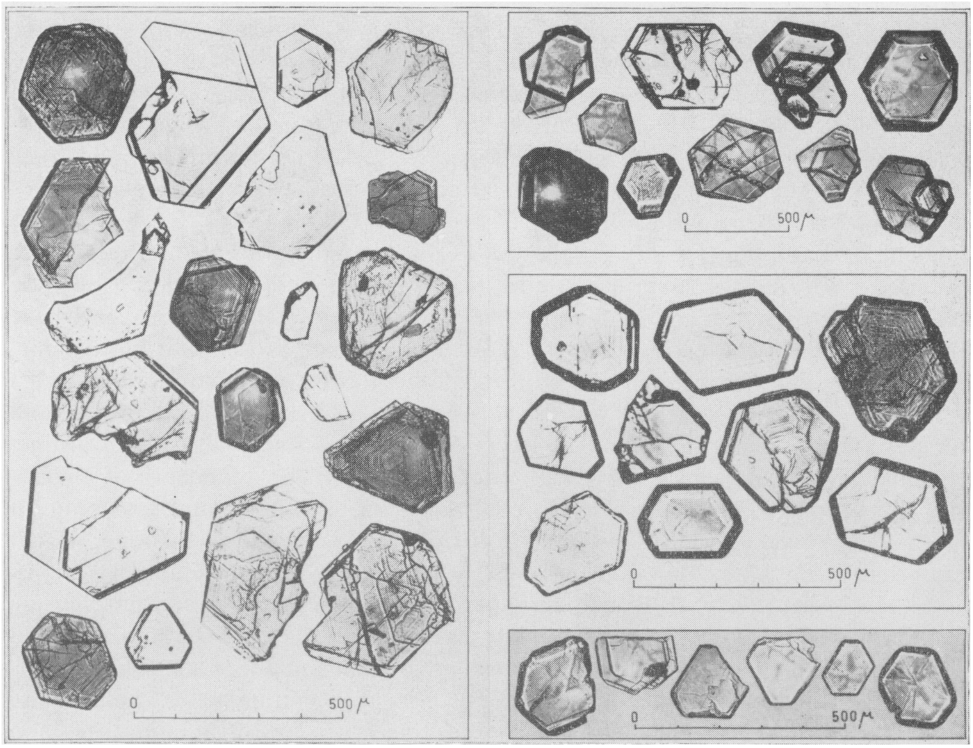


FIGS. 1 and 2: FIG. 1 (left). Situation of the Jornal area (fig. 2). FIG. 2 (right). The veins of the Jornal area: 1, Tantalite vein; 2, Maruim; 3, Passatudo; 4, Evaldo II; 5, Evaldo I; 6, Tantalite Creek; 7, Maraguji I; 8, Maraguji II; 9, Lourenço; 10, Yagú.

A spectrochemical analysis, made by Dr. C. V. Dutra, of the nigerite from the pegmatite of this vein is included in Table I. The high SiO_2 content can be compared to a nigerite from Siberia (Ginsburg *et al.*, 1961) but not to another nigerite from Amapá also analysed by Dutra and published by Baptista and Baptista (1968). The ZnO content is higher than in other analysed nigerites.

In the soils both on top of the vein and on the country-rock (schist), andalusite is the preponderant heavy mineral.

Evaldo's vein II (fig. 2, 4). At this location, two irregular zones of veins and veinlets with their apophyses join to form a Y. The width of the two main veins varies from 1 to 8 m. They consist of a kaolinitic mass, with quartz, muscovite, and concentrations of tourmaline. For several years the veins were worked for cassiterite. The heavy concentrate of the kaolinitic material carries cassiterite, green tourmaline, and a small amount of brown tourmaline; in some samples nigerite is common, in others it is present as a trace only. The nigerite of this vein is weakly coloured, and colourless in thin flakes.



FIGS. 3 and 4: FIG. 3 (left). Nigerite from the pegmatite of the Maruim vein. Even in very thin transparent plates the orange-brown colour is distinct. FIG. 4 (right). *a* (top), orange-brown nigerite from quartz–mica rock of the Lourenço vein. The basal plates have well-developed pyramidal faces; some grains are grown together along the basal face, either with or without the same crystallographic orientation. *b* (centre), nigerite from pegmatite of Evaldo vein I. Nearly all nigerite in this vein is colourless except for a few dark brown grains, one of which is shown in the upper right corner. *c* (bottom), alluvial nigerite from Tantalite Creek. Colourless grains, probably all derived from one vein.

TABLE I. *Analyses by optical spectrography of nigerite from Amapá (anal. C. V. Dutra)*

	1	2	
Al_2O_3	51·90	51·0	1. From quartz–mica rock; ω 1·791, ε 1·797; D 4·08, H. 6; honey-yellow (Baptista and Baptista, 1968).
SnO_2	29·00	21·5	
ZnO	9·50	12·0	
Fe_2O_3	7·60	9·5	2. From pegmatite of the Maruim vein; ω 1·79, ε 1·80; D 4·48, H. about 8; colour varies from reddish brown to amber yellow.
H_2O	0·42	0·5	
Total	100·82*	99·0†	

* includes Ta_2O_5 2·00, Nb_2O_5 0·20, MnO and MgO traces, SiO_2 0·20.
† includes TiO_2 trace, SiO_2 4·5.

Evaldo's vein I (fig. 2, 5). This vein with a width of up to 5 m and a length of at least 100 m has been worked for several years for cassiterite. The only visible feature is the hole that the diggers left. In the tailings pieces of vein quartz can be found, part of them very rich in tourmaline. Also occurring are fragments of quartz–mica rock, and kaolinized feldspar crystals up to 8 cm in size. A concentrate of the vein material—kaolin with coarse quartz and muscovite—carries cassiterite, tourmaline, and some nigerite. The nigerite occurs as very regular and lustrous hexagonal plates, with few cracks, and mostly colourless (fig. 4b).

Tantalite creek (fig. 2, 6). In an alluvial digging near the head of this creek ('José Aguiar') fragments of coarse quartz–mica rock can be found in the tailings. Under the alluvials, the diggers found a kaolinized vein 1 m wide, which was not seen by the writer. The heavy concentrate of crushed quartz–mica rock carries clear-blue gahnite up to 1 mm, chrysoberyl, and traces of andalusite, tourmaline, and cassiterite.

A hundred metres downstream from this point, the creek alluvials (both bedsand and flatgravel) contain nigerite. This occurs as colourless basal plates with distinct pyramidal faces, and with few cracks (fig. 4c), together with an abundance of andalusite and tourmaline and accessories zircon, staurolite, sillimanite, and cassiterite. In a sample of gravel taken just upstream of 'José Aguiar' no nigerite was found, so that the origin of the grains downstream is almost certainly the vein at that place.

Lourenço vein (fig. 2, 9). Evidence of the presence of a vein can be found on the slopes on both sides of the creek, in the form of fragments of quartz–mica rock and mica leaves. On the left side in an abandoned pit, a small amount of laterized kaolin is visible, with coarse quartz and muscovite. The heavy concentrate of the kaolin shows cassiterite with tourmaline and zircon, and traces of chrysoberyl, nigerite, and sillimanite. On the right side, the soil with fragments of quartz–mica rock gave andalusite with nigerite, zircon, and gahnite, and as accessories staurolite, garnet, chrysoberyl, cassiterite, and sillimanite. A weathered fragment of quartz–mica rock had, in its heavy concentrate, nigerite and chrysoberyl, with a little tourmaline. A little higher, at the upper end of the slope, the soil contains tourmaline and andalusite, with zircon, nigerite, staurolite, and as accessories chrysoberyl, cassiterite, and sillimanite. The nigerite of this vein usually presents cracks, and is coloured even in tiny crystals. Many grains show well-developed pyramidal faces. Some are grown together along basal faces, either with the same crystallographic orientation or not (fig. 4a). The soil sample of the right side contains a few very dark grains, of intense brown.

Alluvial nigerite

The vein area is drained by two creeks: Jornal creek (Maruim, Passatudo, Tantalite vein, Evaldo II, Evaldo I, and Tantalite creek) and Maragují creek (Maragují I and II, Lourenço, Yagú). Some samples were taken from the alluvials near the veins, others a few kilometres downstream near the mouths of the creeks.

The three types of alluvials—bedsand, fine alluvials of the flat (alluvial plain), and flatgravel—of the two creeks have quite similar heavy concentrates. There is an abundance of andalusite and much brown tourmaline, with staurolite, sillimanite, and zircon. In the vein area, garnet is always present and is locally common; it is not found close to the mouths of the creeks. In the Jornal creek only, rutile is a common accessory and anatase occurs as traces.

The vein minerals—bluish green tourmaline, gahnite, cassiterite, nigerite—are present only as accessories or traces, even immediately downstream from the veins. The diggers who tried to work the alluvials for cassiterite and columbotantalite were not successful. A systematic Banka drilling of the flatgravel of Jornal creek gave negative results.

The samples taken near the mouths of the two creeks, several kilometres from the vein area, gave divergent results as to the presence of nigerite. In Jornal creek, blue-green tourmaline, cassiterite, and gahnite are present as easily detectable traces. There is more fine cassiterite in the fine alluvials of the creekflat than in the bedsand. No nigerite was found here. In Maragují creek gahnite, blue-green tourmaline, cassiterite, and also nigerite are present as easily detectable traces. As we cannot exclude the possibility of the existence of a vein with nigerite near the mouth of this creek it cannot be definitely concluded that nigerite is able to survive a transport of several kilometres.

It is certain that nigerite crystals, once loose in the drainage system, support transport over at least a few hundred metres. Whether transport over several kilometres occurs can only be found out by a more detailed sampling.

The presence of the other vein minerals (cassiterite, blue-green tourmaline, and gahnite), near the mouths of the two creeks, shows that the microscopic analysis of the translucent heavy minerals of small samples taken from superficial alluvials may serve as a prospecting method to localize tin–tantalum veins.

A sample of quartz–sillimanite rock

After the discovery of nigerite in the Jornal area, the writer examined, in the 'Laboratório de Análises e Pesquisas' in Macapá, samples of tin–tantalum veins collected by L. Cavalcante, formerly director of that laboratory. One of these samples contains nigerite in quantity. It is a quartz–sillimanite rock, with nigerite, cassiterite, and some chrysoberyl. This type of rock has been recorded before from Nigeria (Jacobson and Webb, 1947).

Isaias creek, a tributary of the Rio Cupixizinho, is given as the place of origin of the sample; the writer sampled some veins at Isaias creek and found them to be different and not containing nigerite. It is possible that the above sample was mislabelled during the decade or more that followed its collection.

The sample is similar in colour and in substance to white chalk. It consists of medium-grained transparent quartz, arranged with a certain lineation, and of white sillimanite found between the quartz, which either follows its lineation or has grown in fanlike and starlike patterns. The cassiterite, bluish black, occurs in lenticules up to 1 cm long, oriented in the same direction as the quartz. The nigerite does not occur—as in the Maruim vein—in clusters, but as isolated crystals dispersed throughout the sample, associated with the sillimanite. The crystals are small, many from 0·1 to 0·4 mm, with an observed maximum of 0·6 mm.

Under the microscope, the heavy concentrate shows an abundance of sillimanite, with nigerite and cassiterite and a little chrysoberyl. Sillimanite, one of the rock-forming minerals, occurs both monocrystalline and vesicular. The nigerite, under the microscope from amber-yellow to a clear orange-brown, is nearly always broken up in fragments in the microscopic preparation. Some small hexagonal plates are also present. The cassiterite is highly pleochroic, from a deep reddish brown to pale green or nearly colourless.

TABLE II. *The presence of nigerite and other heavy minerals in the veins of the Jornal area, Amapá*

	Kaolin	Quartz–mica rock
Tantalite vein +	–, cassiterite	?? (+), cassiterite, chrysoberyl, tourmaline
Maruim vein +	++, with chrysoberyl, andalusite, (cassiterite)	++, with sillimanite, chrysoberyl, tourmaline, (cassiterite)
Passatudo ?	(+) ??	n.a.
Evaldo's vein II +	+, cassiterite, tourmaline	n.a.
Evaldo's vein I +	+, cassiterite, tourmaline	n.a.
Tantalite creek +	n.a.	–, gahnite, chrysoberyl
Maragují vein I +	(+), *tourmaline*, (cassiterite)	–, (tourmaline)
Maragují vein II +	–, *tourmaline*, gahnite	–, (tourmaline)
Lourenço's vein +	+, cassiterite, tourmaline, (chrysoberyl)	++, chrysoberyl (tourmaline)
Yagu's vein +	?? –, *tourmaline*, gahnite	n.a.

++ Nigerite abundant
+ Nigerite present
(+) Nigerite as traces
– Nigerite absent
? Presence of nigerite uncertain

n.a. Not analysed
?? Contaminated material
Mineral italicized: abundant
(Mineral) between parenthesis: traces

Conclusions

The Amapá nigerite is different from the Portuguese type (tiny crystals with predominant negative sign), but similar to the Nigerian type (up to a few millimetres in size and optically positive). This type, occurring in Nigeria, Siberia, Rondônia, and Amapá, seems to be the more common. Nigerite, once known, is easily recognized, the bigger crystals with the naked eye, the smaller ones with the lens or microscope.

In the veins of Jornal area, nigerite is a common mineral, but occurs in small quantities. The crystal habit—and possibly its chemical composition—is different from one vein to another. In most cases its colour under the microscope is a golden brown similar to that of staurolite and is evident even in very thin flakes. In some veins the nigerite is colourless and in others a very dark variety was found. In one vein all crystals have cracks, in others many are perfect. Generally the more coloured crystals are more fractured than the colourless ones. The hexagonal plates can be angular, or smooth and with roundish margins. In some veins pyramidal faces are inconspicuous, in others they are well developed. Zoning can be rare or frequent.

Where nigerite occurs an attempt was made to establish whether it does so in the pegmatite or in the quartz–mica rock, and which are the associated translucent heavy minerals; the results are shown in Table II. Some regularities can be inferred from Table II:

Nigerite can occur both in the pegmatite and in the quartz–mica rock.

When gahnite is present, there is neither nigerite nor cassiterite, and when nigerite is present, cassiterite is usually present also.

In order to understand the second rule, we plot the chemical composition of analysed nigerites in the system Al_2O_3–ZnO–SnO_2 (fig. 5). It can be seen that the SnO_2/Al_2O_3 ratios are all close to 1 : 3 ($SnAl_6O_{11}$), as deduced by Bannister *et al.* (1947) for the Nigerian nigerite; the atomic Zn/Sn ratio can vary around 1 : 1 and 1 : 2 ($ZnSnO_3$ and $ZnSn_2O_5$). Of course the other elements have been disregarded here, because of insufficient data on FeO and Fe_2O_3 content; even when taking them into account the spreading in composition would be hardly less. However, the diagram helps to visualize that, in Al-rich surroundings, we may expect either nigerite and gahnite, nigerite alone, or nigerite and cassiterite, depending on the Zn/Sn ratio; gahnite and cassiterite are not in equilibrium.

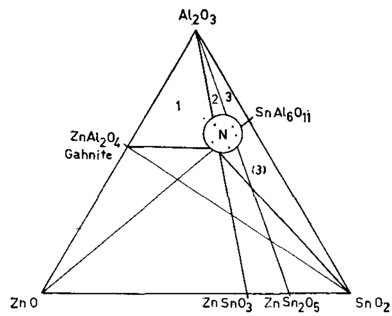


FIG. 5. The system ZnO–SnO_2–Al_2O_3. N, nigerite; dots, analysed nigerites. In Al-rich surroundings there may form nigerite plus gahnite (area 1), nigerite alone (area 2), or nigerite plus cassiterite (area 3).

Looking back now at Table II, the distribution of gahnite, nigerite, and cassiterite in the Amapá veins can be readily explained if a little Zn is introduced in the veins first, forming gahnite, later followed in part of the veins by an amount of Sn much in excess of Zn, so that cassiterite and nigerite form, the latter incorporating the Zn of the gahnite. Possibly the coating of gahnite by nigerite that has been observed in Nigeria (Jacobson and Webb, 1947) and in Portugal (Mayer, 1965) occurs only when the Sn is not in excess of the Zn. That nigerite forms at the same time as cassiterite—during the introduction of Sn into the veins—is corroborated by the fact that nigerite has been observed as inclusions in cassiterite (Mayer, 1965) and cassiterite as inclusions in nigerite (Guimarães and Teixeira da Costa, 1957). The data from Amapá, however, are rather scant, and both hypotheses—that nigerite is contemporaneous with cassiterite and that gahnite disappears when excess Sn enters the veins, its Zn being used in the formation of nigerite—need confirmation from other parts of the world.

REFERENCES

BANNISTER (F. A.), HEY (M. H.), and STADLER (H. P.), 1947. *Min. Mag.* **28**, 129–36.

BAPTISTA (A.) and BAPTISTA (N. R.), 1968. *An. XXII Cong. Geol. Bras.*, Belo Horizonte, 119–24.

GINZBURG (A. I.), NAZAROVA (A. S.), and SUKHOMAZOVA (L. L.) [Гинзбург (А. И.), Назарова (А. С.), и Сухамазова (Л. Л.)], 1961. In *New data on rare elements mineralogy*, 42. Translated by Consultants Bureau Enterprises Inc., New York, 1963.

Guimarães (D.) and Teixeira da Costa (M.), 1957. Unpublished report. Belo Horizonte.
Jacobson (R.) and Webb (J. S.), 1946. *Geol. Survey Nigeria, Bull.* **17.**
—— —— 1947. *Min. Mag.* **28,** 118–28.
Kloosterman (J. B.), 1969*a*. *VIII Guiana Geol. Conf.*, Georgetown.
—— 1969*b*. *An. Acad. Bras. Ciênc.* **41** (4), 565–70.
—— 1972. Ibid. **44** (2), 245–9.
—— 1974. *Mineração Metalurgia*, **354** (8), 18–19.
Macdonald (R.) and Saunders (M. J.), 1973. *Min. Mag.* **39,** 97–111.
Mayer (C.), 1965. *Geological investigations in the Amarante region (Northern Portugal), with special reference to the mineralogy of the casserite-bearing albite pegmatites.* Thesis, Amsterdam.
Morães (L. J. de), 1959. Bauxites et autres richesses minières du Terr. Féd. d'Amapá (Brésil). *Mém. Carte Géol. France, dept. Guyane fr.*
Van Tassel (R.), 1965. *Min. Mag.* **34,** 482–6.

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