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Pandaïte, Baddeleyite and Associated Minerals from the Bingo Niobium Deposit, Kivu, Democratic Republic of Congo

L. VAN WAMBEKE
Joint Research Centre, Euratom, Ispra, Varese, Italy

Pandaïte, cut by numerous veinlets of a crandallite containing Sr, Ba and RE was found during an investigation of the pyrochlore mineralization of the important niobium deposit of Bingo. The alkaline rocks of the Bingo area also contain locally a particular mineral association of baddeleyite and cassiterite in veinlets.

De la pandaïte, recoupée par de nombreuses veinules de crandallite riche en Sr, Ba et TR, a été décelée durant une étude de la minéralisation à pyrochlore de l'important gisement de niobium de Bingo. Les roches alcalines de la région de Bingo contiennent localement une association minérale particulière constituée par de la baddeleyite et de la cassitérite en veinules.

The important niobium deposit of Bingo (Mount Home) in the north-eastern part of the Kivu, Democratic Republic of Congo (Kinshasa), was discovered in 1958 by the applications of two main methods suggested by the author: first, radiometric measurements in the field and, secondly, analyses of lateritic soils in the laboratory (L. VAN WAMBEKE 1960). X-ray fluorescence analysis has shown large amounts of Nb and other metals in the soils as well as the typical geochemical association Nb-Sr-Ba-RE of carbonatite deposits observed also at Araxa, Brazil, and at Lueshe, Congo.

Pandaïte and Associated Crandallite

A series of pyrochlore crystals of white cream colour were investigated by X-rays, optical microscopy and Castaing electron microprobe analysis. A chemical analysis was also made of selected crystals. These investigations clearly indicate the presence of pandaïte in this deposit. This mineral, not previously found in the Congo, is known from Panda Hill, Tanzania and from Araxa, Brazil (JÄGER *et al.* 1959; VAN DER VEEN 1963). Table 1 gives the results of the chemical analysis, with impurities deduced. These were determined by optical microscopy and by electron microprobe analysis. Under the microscope, in addition to some rare inclusions of rutile and ilmenite, the pyrochlore is cut by numerous veinlets (Photo 1). The electron microprobe analysis has shown that these veinlets are composed of quartz and, in particular, of an aluminium phosphate containing the major part of the Ca and Sr. Ba and the rare earths are only present in small amounts in the veinlets.

The pyrochlore matrix contains the Ba and the rare earths. Ca and Sr are only present as trace elements.

The phosphate mineral present in the numerous veinlets is thus a crandallite containing some Sr, Ba and rare earths. This mineral gives a poor X-ray diffraction pattern and only three large lines of weak intensity at 2.97, 3.50 and 5.7 Å are present. The width of these lines indicates that the mineral most probably has been leached by alteration.

The calculated parameter value of the pyrochlore $a_0 = 10.58 \pm 0.007$ Å is similar to that found for pandaïte and agrees well with the

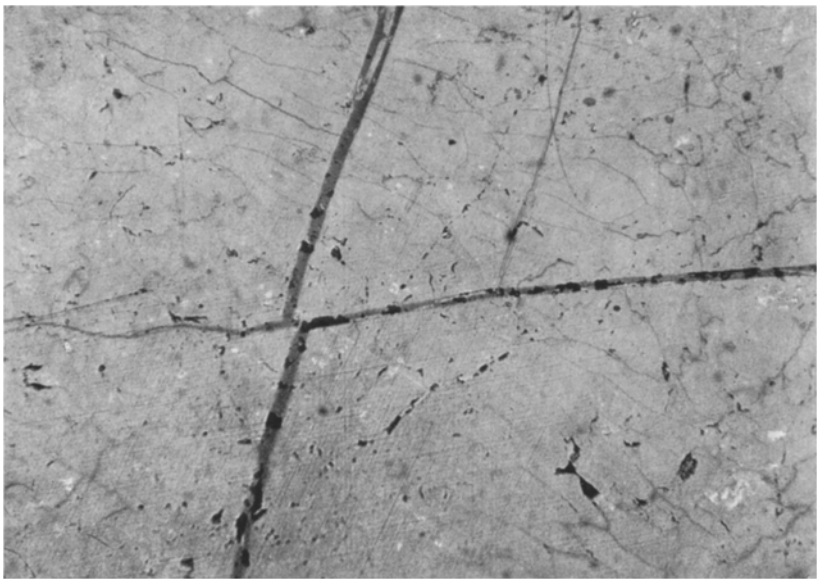

Fig. 1. Veinlets of quartz and crandallite containing some Sr, Ba and rare earths cutting the pandaïte matrix (50 ×)

Table 1. *Chemical Analysis of Pandaïte crystals*

Elements* analyzed	% weight	pandaïte (impurities deduced) *approximate*
Na_2O	0.02	0.02
CaO	0.6	0.05
SrO	0.3	0.03
BaO	12.45	11.82
Σ Re oxides	1.70	1.6
ThO_2	1.60	1.60
U_3O_8	0.15	0.15
Nb_2O_5	50.55	50.55
Ta_2O_5	0.1	<
TiO_2**	1.38	1.3
Fe_2O_3	3.35	2.8
ZrO_2	3.0	3.0
$Al_2O_3 + P_2O_5$	9.8	
SiO_2***	4.	
MnO_2	0.1	
H_2O+	9.10	7.3
H_2O-	1.25	
	99.35	

* Contains also small amounts of Pb, Sn, K and F (0.02%).

** Mineral impurities:
major — a crandallite with some Sr, Ba, RE SiO_2 mainly quartz
accessory — limonite (0.5—0.6%) rare inclusions of rutile — ilmenite, manganese oxide

*** All iron analyzed as Fe_2O_3.

chemical composition (JÄGER *et al.* 1959). Other pyrochlores of similar parameter value are safiannikoffite, a hydrated potassium — pyrochlore (L. VAN WAMBEKE 1965) and plumbopyrochlore — a lead pyrochlore (SKOROBOGATOVA *et al.* 1966), but in the Bingo material K and Pb are present in very small amounts. After deduction of the mineral impurities, the approximate formula for the pandaïte of Bingo is:

$$[Ba_{0.34}\ RE_{0.045}\ Th_{0.025}\ (Ca, Na, U, Sr)_{0.01}]$$
$$[Nb_{1.67}\ Fe^{III}_{0.15} Zr_{011}\ Ti_{0.07}]\ O_{5.22}\ (OH)_{1.78}$$

Part of the total Fe present most probably occurs as Fe^{II} in the A positions. This pandaïte

shows large deficiencies in A ions and only 20—25% of the A positions are occupied. The same fact has been found in other pandaïtes (JÄGER *et al.* 1959; VAN DER VEEN 1963). The mineral from Bingo is a hydrated rare-earth variety of pandaïte. Pandaïte is a characteristic mineral of the hydrothermal stage of carbonatitic differentiation and is generally formed by A-ion replacement of Ca-Na pyrochlore of earlier formation (L. VAN WAMBEKE 1970).

Baddeleyite and Associated Cassiterite

The alkaline rocks of Bingo are locally cut by radioactive veinlets. This material has been investigated by the combined X-ray diffraction-fluorescence method. The fluorescence analysis has shown, besides the main element Zr, notable amounts of Sn and Nb (2—3%). Th and Fe are also present in small amounts.
The X-ray diffraction pattern shows baddeleyite lines and weak but distinct cassiterite lines. Columbite may also be present. This particular association of baddeleyite and cassiterite has not been previously observed in alkaline rocks. However, a tin-bearing mineral, sörensenite, has been discovered in analcime veins in the alkaline intrusion of Ilimaussaq, Greenland (SEMENOV *et al.* 1965).

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Dr. L. VAN WAMBEKE
Joint Research Centre, Euratom, Ispra, Varese, Italy and commission of the European Communities 23—27, avenue de la Joyeuse Entrée, Brussels 4 Belgium