

STABILITY OF THE ALLUAUDITE + TRIPHYLITE PARAGENESIS IN GRANITIC PEGMATITES, AND FIRST EXPERIMENTAL EVIDENCE OF SODIUM INCORPORATION INTO TRIPHYLITE

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The petrographic relations between alluaudite and triphylite indicate that these phosphate minerals have crystallized simultaneously in the Li-rich granitic pegmatites of Buranga, Kibingo (Rwanda), and Hagedorf-Süd (Germany) (Fransolet *et al.*, 1994, 1997, 1998 and 2004). Starting from chemical compositions corresponding to the idealized compositions of these two phosphates, an experimental investigation was initiated in order to constrain the conditions under which the alluaudite + triphylite paragenesis crystallizes in granitic pegmatites.

The hydrothermal syntheses were carried out between 400 and 800°C at 0.1 GPa, using vertically arranged Tuttle-type cold-seal bombs. The oxygen fugacity was controlled by the Ni-NiO buffer. Below 600°C, alluaudite is associated with triphylite, whereas maricite appears between 600 and 700°C. At 800°C, an undetermined phase, named "X-phase", crystallizes together with triphylite (Figure 1).

Because maricite has never been observed in granitic pegmatites as far as we know, the upper stability limit of the alluaudite + triphylite paragenesis corresponds to 600°C. This temperature is in good agreement with the conditions generally considered to occur in granitic pegmatites.

The determination of the unit-cell parameters of alluaudite and triphylite serves to estimate semi-quantitatively the Fe/(Fe + Mn) ratios of these phosphates at 400 and 500°C, whereas electron microprobe analyses were performed on the larger crystals obtained between 600 and 800°C. The partitioning coefficients of Fe and Mn between alluaudite and triphylite are compared to those measured on the natural phosphates.

The electron microprobe analyses also indicate that triphylite contains significant amounts of sodium (up to 1.45 wt. % Na₂O at 800°C), and that maricite contains significant amounts of lithium (up to 0.86 wt. % Li₂O at 700°C). The lithium contents of alluaudite and "X-phase" can not be calculated from the microprobe analyses, but the presence of lithium in the alluaudite structure is likely since Hatert *et al.* (2000 and 2002) and Hatert (2004) have shown that Li can be inserted into the A(1) site of the structure. Further SIMS analyses are necessary to measure accurately the Li content of these phosphates.

References

- Fransolet, A.-M., Antenucci, D., Fontan, F., Keller, P. (1994): New relevant data on the crystal chemistry, and on the genetical problem of alluaudites and wyllieites. *Abstracts of the 16th IMA general meeting, Pisa*, 125-126.
- Fransolet, A.-M., Keller, P., Fontan, F. (1997): The alluaudite group minerals: Their crystallochemical flexibility and their modes of formation in the granite pegmatites. *Abstracts of the meeting "Phosphates: biogenic to exotic", London*.
- Fransolet, A.-M., Fontan, F., Keller, P., Antenucci, D. (1998): La série johnsomervilleite-fillowite dans les associations de phosphates de pegmatites granitiques de l'Afrique centrale. *Canadian Mineralogist*, **36**, 355-366.
- Fransolet, A.-M., Hatert, F. & Fontan, F., (2004): Petrographic evidence for primary hagedorfite in an unusual assemblage of phosphate minerals, Kibingo granitic pegmatite, Rwanda. *Canadian Mineralogist*, **42**, 697-704.
- Hatert, F., Keller, P., Lissner, F., Antenucci, D., Fransolet, A.-M. (2000): First experimental evidence of alluaudite-like phosphates with high Li-content: the (Na_{1-x}Li_x)MnFe₂(PO₄)₃ series (x = 0 to 1). *European Journal of Mineralogy*, **12**, 847-857.
- Hatert, F., Antenucci, D., Fransolet, A.-M., Liégeois-Duyckaerts, M. (2002): The crystal chemistry of lithium in the alluaudite structure: a study of the (Na_{1-x}Li_x)CdIn₂(PO₄)₃ solid solution (x = 0 to 1). *Journal of Solid State Chemistry*, **163**, 194-201.
- Hatert, F. (2004): The crystal chemistry of lithium in the alluaudite structure: a study of the (Na_{1-x}Li_x)_{1.5}Mn_{1.5}Fe³⁺_{1.5}(PO₄)₃ solid solution (x = 0 to 1). *Mineralogy and Petrology*, **81**, 205-217.

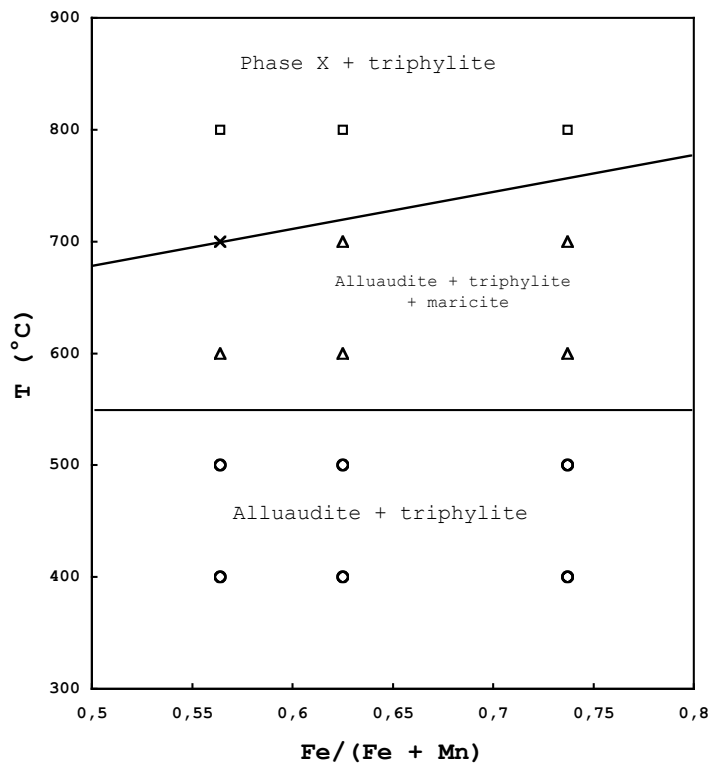


Figure 1.