Ferriperbøeite-(Ce), $[CaCe_3]_4[Fe^{3+}Al_2Fe^{2+}]_4[Si_2O_7]_4[SiO_4]_3O(OH)_2$, a new member of the polysomatic epidote–törnebohmite series from the Nya Bastnäs Fe-Cu-REE deposit, Sweden

LUCA BINDI1,2,*; DAN HOLTSTAM3; GIULIA FANTAPPië1; ULF B. ANDERSSON4 and PAOLA BONAZZI1

1 Dipartimento di Scienze della Terra, Università degli Studi di Firenze, via G. La Pira 4, 50121 Firenze, Italy
2 Corresponding author, e-mail: luca.bindi@unifi.it
3 Department of Geosciences, Swedish Museum of Natural History, Box 50007, 104 05 Stockholm, Sweden
4 Luossavaara-Kiirunavaara AB, R&D, TG, 981 86 Kiruna, Sweden

Abstract: Ferriperbøeite-(Ce), ideally $[CaCe_3]_4[Fe^{3+}Al_2Fe^{2+}]_4[Si_2O_7]_4[SiO_4]_3O(OH)_2$, is a new mineral species from the Nya Bastnäs Fe–Cu–REE skarn deposit in the Bergslagen mining region (south-central Sweden). The mineral occurs in direct contact with ferriallanite-(Ce), cerite-(Ce) and törnebohmite-(Ce). In the type specimen, ferriperbøeite-(Ce) forms brownish black crystals, and exhibits an irregular to short-prismatic morphology elongated along [0 1 0]. The maximum crystal size is about 500 $\mu$m. The mineral is optically biaxial positive, with $2V = 65 \pm 5^\circ$. It is strongly pleochroic from green, throughout orange-brown, to deep red colours. Electron microprobe analyses yields the empirical formula, calculated on the basis of 13 cations and divalent and trivalent iron partitioned all the criterion of charge balance, $(Ca_{0.92}La_{1.23}Ce_{1.50}Pr_{0.10}Nd_{0.27}Sm_{0.02}Y_{0.01})\Sigma_{4}\{Fe^{3+}Al_2Fe^{2+}\}\Sigma_{4}[Si_2O_7][SiO_4]_3O(OH)_2$, which is in accord with single-crystal X-ray diffraction, infra-red, and Mössbauer spectroscopy data. The mineral is monoclinic, space group $P2_1/m$, with unit-cell parameters: $a = 8.9320(4)$, $b = 5.7280(3)$, $c = 17.5549(9)$, $\alpha = 90^\circ$, $\beta = 116.030(4)^\circ$, $\gamma = 90^\circ$. It exhibits a dissakisite-(Ce) composition in gatelite-(Ce), whereas for alnaperbøeite-(Ce) the $E$ module corresponds to a new, Na-bearing REE-epidote composition $[(Ca,REE,Na)Al_3(SiO_4)O(OH)]$. However, minerals having an $E$ module corresponding to a ferriallanite-(Ce) $[(Ca,REE,Na)Al_3(SiO_4)O(OH)]$ have also been reported: the Fe–O analogue of västmanlandite-(Ce) without $F$ (labelled as UM2007-35 in the list of unnamed minerals; Smith & Nickel, 2007) from the Bergslagen region (Sweden) was noted by Holtstam & Andersson (2007), and a similar mineral is reported from carbonatite veins in Eastern Siberia, Russia (Gurzhyi et al., 2010) and from a metamorphosed carbonatite sill in British Columbia, Canada (Ya’acoby, 2011).

The present paper reports the results of a chemical, structural and spectroscopic study of the sample #52:414, preliminary analysed by Holtstam & Andersson (2007), leading to the definition and description of a new member of the supergroup. By analogy with the IMA-approved nomenclature for the epidote supergroup minerals, and to underline the substitutational relationships with perbøeite-(Ce), the mineral was named ferriperbøeite-(Ce). The mineral and the mineral name have been approved by IMA-CNMNC (2017–037). The holotype material, including a polished thin section, is deposited at the Swedish Museum of Natural History, Department of Geosciences, Box 50007, SE-10405 Stockholm, Sweden, under collection number NRM #52:414 = UM2007-35.

1. Introduction

Minerals belonging to the gatelite supergroup (Bonazzi et al., 2017) can be regarded as iso-topological ET polysomes of a series having epidote and törnebohmite-(Ce) as end-members. They include gatelite-(Ce) (Bonazzi et al., 2003), västmanlandite-(Ce) (Holtstam et al., 2005), perbøeite-(Ce) and alnaperbøeite-(Ce) (Bonazzi et al., 2014). While the $T$ module exhibits an almost invariable composition, the variable composition of the $E$ module differentiates each member. In particular, the $E$ module exhibits a dissakisite-(Ce) composition in gatelite-(Ce), dollaseite-(Ce) composition in västmanlandite-(Ce), and allanite-(Ce) composition in perbøeite-(Ce), whereas for alnaperbøeite-(Ce) the $E$ module corresponds to a new Na-bearing REE-epidote composition $[(Ca,REE,Na)Al_3(SiO_4)O(OH)]$. However, minerals having an $E$ module corresponding to a ferriallanite-(Ce) $[(Ca,REE,Na)Al_3(SiO_4)O(OH)]$ have also been reported: the Fe–O analogue of västmanlandite-(Ce) without $F$ (labelled as UM2007-35 in the list of unnamed minerals; Smith & Nickel, 2007) from the Bergslagen region (Sweden) was noted by Holtstam & Andersson (2007), and a similar mineral is reported from carbonatite veins in Eastern Siberia, Russia (Gurzhyi et al., 2010) and from a metamorphosed carbonatite sill in British Columbia, Canada (Ya’acoby, 2011).

The present paper reports the results of a chemical, structural and spectroscopic study of the sample #52:414, preliminary analysed by Holtstam & Andersson (2007), leading to the definition and description of a new member of the supergroup. By analogy with the IMA-approved nomenclature for the epidote supergroup minerals, and to underline the substitutational relationships with perbøeite-(Ce), the mineral was named ferriperbøeite-(Ce). The mineral and the mineral name have been approved by IMA-CNMNC (2017–037). The holotype material, including a polished thin section, is deposited at the Swedish Museum of Natural History, Department of Geosciences, Box 50007, SE-10405 Stockholm, Sweden, under collection number NRM #52:414 = UM2007-35.