Canadian Mineralogist
Vol. 23, pp. 489-490 (1985)

HYDROXYAPOPHYLLITE IN HORNFELS BENEATH THE DULUTH COMPLEX, NORTHEASTERN MINNESOTA

CHRISTOPHER I. CHALOKWU
Department of Geology, Auburn University, Auburn, Alabama 36849, U.S.A.

YU-CHYI YAU
Department of Geological Sciences, University of Michigan, Ann Arbor, Michigan 48109, U.S.A.

ABSTRACT

Hydroxyapophyllite has been found in metasedimentary hornfels at a depth of 637 metres of a 653-m-long drill core through the Partridge River intrusive complex. The occurrence of hydroxyapophyllite is restricted to zones laden with xenoliths of graphic granite, which suggests that the hydroxyapophyllite formed as a reaction product distinct from the deuteric alteration of the overlying troctolite and gabbro. The mineral shows the forms {001} and {010}; it is found in association with radiating crystals of natrolite and minor chabazite.

Keywords: hydroxyapophyllite, Minnesota, Partridge River intrusive complex, Duluth Complex, deuteric alteration.

SOMMAIRE

On a découvert de l'hydroxyapophyllite dans une cornéenne métasédimentaire à 637 mètres de profondeur dans un forage de 653 m à travers le complexe intrusif de Partridge River. Elle se trouve seulement aux niveaux riches en xénolithes de granite graphique; ceci fait penser que l'hydroxyapophyllite est un produit de réaction et non de l'altération deutérique de la troctolite et du gabbro susjacents. Les cristaux montrent les formes {001} et {010}; ils sont associés à la natrolite, en cristaux fibroradiés, et à un peu de chabazite.

(Traduit par la Rédaction)

Mots-clés: hydroxyapophyllite, Minnesota, complexe intrusif de Partridge River, complexe de Duluth, altération deutérique.

INTRODUCTION

Hydroxyapophyllite $KCa_4Si_8O_{20}(OH)\cdot 8H_2O$ and fluorapophyllite $KCa_4Si_8O_{20}F\cdot 8H_2O$ have been defined by Dunn *et al.* (1978) as the end members of the apophyllite series. Apophyllite occurs mostly in cavities in basalts and related rocks, commonly in association with zeolite minerals. Less commonly, it occurs in hydrothermal veins with Cu-sulfide mineralization, as in the Lake Superior copper district. We follow the nomenclature of Dunn *et al.* in describing an unusual occurrence of hydroxyapophyllite in the Duluth Complex, in drill core DDH-371 (T60N, R12W, northeastern Minnesota). The geology of the Duluth Complex was recently summarized by Weiblen & Morey (1980) and by Weiblen (1982).

The specimen described in this report occurs in a vug in metasedimentary hornfels. The zone of hornfels consists of xenoliths of the underlying Virginia Formation in the Partridge River intrusive complex (Fig. 1a) some 637 metres below the surface. The hydroxyapophyllite is associated with zeolites such as chabazite and natrolite. The hydroxyapophyllite-bearing hornfels occurs with fragments of graphic granite in which feldspar is an exsolution perthite (Fig. 1b); the fragments are interpreted as xenoliths of the Archean basement. This restricted occurrence suggests that the hydroxyapophyllite formed as a reaction product distinct from the deuteric alteration of the overlying troctolite and gabbro. The footwall metasedimentary Virginia Formation occurs here at a depth of 653 m.

X-RAY ANALYSIS

X-ray powder-diffractometer data (Table 1) were gathered using a Philips diffractometer equipped with a theta-compensating slit. Ni-filtered Cu radiation and 1°/min scan rate were employed. A least-squares refinement of the powder-diffraction data assuming the constraints of the tetragonal space-group gave the following cell-dimensions: a 8.978(3), c 15.906(9) Å. The cell volume is 1282(1) Å^3, and the c/a axial ratio is 1.772.

CHEMISTRY

Quantitative analyses of hydroxyapophyllite were performed on the University of Michigan ARL EMX electron microprobe (wavelength dispersion) using PET, LIF and TAP crystal spectrometers (Table 2). The operating conditions were: accelerating voltage 12 kV, sample current 0.015 μA, beam diameter 1–2 μm, counting time 22 to 30 seconds. Adularia was used as a standard for K, Al and Si, hornblende for Fe, clinopyroxene for Ca, albite for Na, and fluorite for F. The standard error for F is about 0.1 wt.%

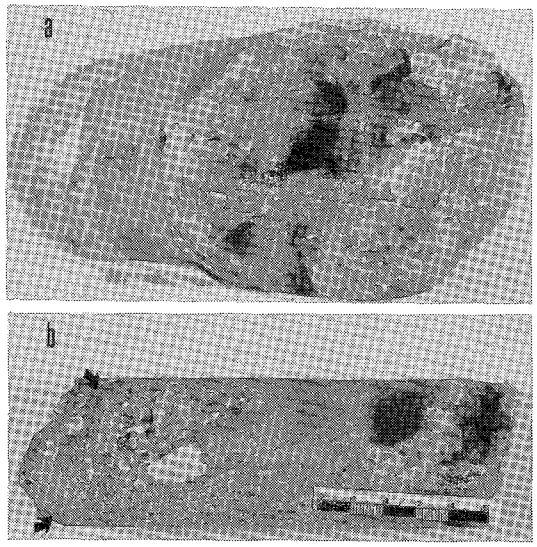

FIG. 1. a) Core with vug containing hydroxyapophyllite. Diameter of core is 4.5 cm. b) View of same core showing fragments of graphic granite. The material containing the granite fragments is a plagioclase–biotite hornfels (see arrows). Scale bar is 5 cm in length.

TABLE 1. X-RAY POWDER PATTERN OF HYDROXYAPOPHYLLITE

Iobs	dobs(Å)	dcal(Å)	hkl
14	7.782	7.82	101
34	4.552	4.565	103
100	3.97	3.977	004
22	3.580	3.584	122
12	3.363	3.370	114
96	2.992	2.999	015
6	2.822	2.825	214
6	2.670	2.674	312
42	2.441	2.446	116
7	2.006	2.008	420
11	1.772	1.774	317
46	1.577	1.579	441
9	1.553	1.554	238

TABLE 2. CHEMICAL COMPOSITION OF HYDROXYAPOPHYLLITE

	Wt.%	# of Atoms*	
SiO_2	52.73	7.97	8.00
Al_2O_3	0.16	0.03	
CaO	24.54	3.98	
K_2O	4.73	0.91	
Na_2O	0.12	0.04	
F-	0.73	0.35	
**OH-	0.90	0.53	
Total	84.81		
***H_2O	15.19		

*On the basis of Si + Al = 8.00. **Amount required for charge balance. ***Obtained by difference. Electron-microprobe data.

and that for other elements is about 0.03 wt.%. The matrix correction of the raw data was made using the program EMPADR VII (Rucklidge & Gasparrini 1969).

We have normalized the chemical composition to Al + Si = 8, with OH = 0.53 based on charge balance to obtain the formula: $(K_{0.91}Na_{0.04}Ca_{3.98})(Si_{7.97}Al_{0.03})(F_{0.35}OH_{0.53})O_{20}\cdot 7.74H_2O$. The composition of the Duluth hydroxyapophyllite agrees well with that reported for hydroxyapophyllite formed in a similar environment in the Ransko gabbro-peridotite massif (Němec 1982).

ACKNOWLEDGEMENTS

We are grateful to Stan Watowich of Amax Exploration for giving us access to core DDH–371. Thanks are due to John Hughes for help with the X-ray analysis, and to Paul Weiblen and an anonymous reviewer for helpful comments on an earlier draft of the note.

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Received December 19, 1983, revised manuscript accepted January 14, 1985.