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CHLORINE-BEARING POTASSIAN HASTINGSITE FROM A SPHALERITE SKARN IN SOUTHERN YUKON

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Abstract

Chlorine-bearing potassian hastingsite occurs in a narrow sphalerite-rich skarn in southern Yukon. Chlorine content of the amphibole ranges from 1.15 to 3.09 wt. %. Based on an average of microprobe analyses and a wet chemical determination of Fe^{2+}, the formula is $(K_{0.45}Na_{0.40})$ $(Na_{0.03}Ca_{1.97})$ $(Fe^{2+}{}_{3.51}$ $Mg_{0.24}Mn_{0.05})$ $Fe^{3+}{}_{0.81}Al_{0.32}Ti_{0.03}Cr_{0.01})$ $Si_{6.09}Al_{1.91}$ O_{22} $(OH_{1.38}Cl_{0.62})$. The unit-cell dimensions are *a* 9.962(3), *b* 18.287(6), *c* 5.360(1)Å, β 104°54(2)', *V* 943.50(34)Å^3; D_{calc} = 3.502, D_{obs} = 3.45(4) g/cm^3. The composition of this amphibole indicates that chlorine was probably an important constituent of the metasomatic fluid during skarn formation.

Sommaire

On a trouvé une hastingsite potassique chlorifère dans une zone étroite de skarn à sphalérite du Yukon méridional. Les analyses à la microsonde de l'amphibole donnent une teneur en chlore de 1.15 à 3.09% (poids); la formule chimique, établie sur la moyenne de ces analyses combinée à une détermination du Fe^{2+} par voie humide, est la suivante: $(K_{0.45}Na_{0.40})$ $(Na_{0.03}Ca_{1.97})$ $(Fe^{2+}{}_{3.51}Mg_{0.24}Mn_{0.05})$ $(Fe^{3+}{}_{0.81}Al_{0.32}$ $Ti_{0.03}Cr_{0.01})Si_{6.09}Al_{1.91}O_{22}$ $(OH_{1.38}Cl_{0.62})$. Les dimensions de la maille sont: *a* 9.962(3), *b* 18.287(6), *c* 5.360(1)Å, β 104°54(2)', *V* 943.50(34)Å^3, D_{calc} = 3.502, D_{obs} = 3.45(4). La composition de cette amphibole indique l'importance probable du chlore dans la phase fluide métasomatique lors de la formation du skarn.

(Traduit par la Rédaction)

Introduction

Chlorine-bearing potassian hastingsite is a major constituent of a 3 m wide skarn zone that formed in Devonian limestone near a small Cretaceous diorite stock at approximately 60°08' N latitude, 134°14' W longitude near the south shore of Crescent Lake (Wolf Lake map sheet 105B, Yukon Territory), approximately 22 km north of the Alaska highway, southern Yukon. It occurs as prismatic, dark green crystals up to 1 cm long in interstices of very coarse-grained, strongly birefringent, compositionally zoned grossular–andradite. The amphibole also occurs in garnet-free parts of the skarn, where it is intimately intergrown with epidote, hedenbergite and quartz. Locally, it is associated with dark, iron-rich sphalerite and commonly rims sphalerite grains. Accessory minerals in the skarn are apatite, allanite and actinolite that coexists with the chlorine-bearing potassian hastingsite.

Chemical and X-ray Data

Thirty-eight energy dispersive analyses of the amphibole were done with an ARL–AMX electron microprobe using instrumental settings of 15 kV and 0.035 mA. NaCl was used as the Cl standard, and three scapolites containing 2.00, 1.90 and 1.75% Cl (Evans *et al.* 1969) were analyzed along with the chlorine-bearing potassian hastingsite to check the accuracy of the method. The mean probe values obtained for these scapolites are 2.09(12)% (three analyses), 2.03(4)% (four analyses) and 1.77(6)% (three analyses), respectively. Ten wavelength-dispersive analyses for F were done using a KAP analyzing crystal, but no F was detected (estimated detection limit 0.5%).

The FeO value reported for sample No. 1 (Table 1) was determined by wet chemical

TABLE 1. MICROPROBE ANALYSES OF CHLORINE-BEARING POTASSIAN HASTINGSITE

	1 (*n* = 7)	2 (*n* = 5)	3 (*n* = 7)	4 (*n* = 12)	5 (*n* = 7)
SiO_2	37.36(46)	37.11(56)	37.90(32)	37.73(84)	38.31(187)
TiO_2	0.29(9)	0.29(14)	0.49(22)	0.55(19)	0.29(20)
Al_2O_3	11.60(30)	11.78(42)	11.59(48)	11.37(66)	10.86(154)
Cr_2O_3	0.08(9)	0.06(6)	0.06(6)	0.10(9)	0.21(7)
Fe_2O_3	6.55(2)	----	----	----	----
FeO	25.70(2)	31.55(31)*	31.29(47)*	31.66(47)*	30.84(44)*
MnO	0.37(12)	0.31(10)	0.41(9)	0.31(12)	0.37(6)
MgO	0.98(26)	0.95(25)	1.30(18)	1.04(12)	1.21(29)
CaO	11.28(22)	11.45(19)	11.45(24)	11.40(18)	11.43(18)
K_2O	2.15(14)	2.06(47)	1.88(11)	2.01(17)	1.81(37)
Na_2O	1.27(20)	1.09(16)	1.24(20)	1.15(23)	1.26(20)
Cl	2.35(39)	2.23(83)	1.97(22)	2.16(17)	2.03(53)
	99.98	98.88	99.58	98.82	98.62
$O \equiv Cl$	0.53	0.50	0.45	0.49	0.46
TOTAL	99.45	98.38	99.13	98.43	98.16

* Total Iron reported as FeO; *n* number of analyses.
Estimated standard deviation is shown in parentheses.

analysis according to the method of Shapiro & Brannock (1962), and Fe_2O_3 was calculated by subtraction from total iron. This sample was chosen for the ferrous–ferric determination and X-ray analysis because it showed the least variation in composition. Insufficient sample precluded an analysis for water.

Powder diffraction data (available from the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Ontario K1A 0S2) were obtained using a Nonius Guinier camera with quartz-monochromatized Cu$K\alpha_1$ radiation and quartz as an external standard. The refined cell parameters are: a 9.962(3), b 18.287(6), c 5.360(1)Å, β 104°54(2)′, V 943.50(34)Å^3. The average density of 3.45(4) g/cm^3, obtained using a Berman torsion balance, agrees closely with the calculated value of 3.502 g/cm^3.

Discussion

Compositional zoning within individual crystals was not observed; however, the chlorine content varies significantly between individual crystals in each sample. Chlorine concentrations range from 3.09% in sample 2 to 1.15% in sample 5. The chemical formula, based on 22 O and (xOH, yCl, F = 0, $x+y$ = 2), is $(K_{0.45}Na_{0.40})$ $(Na_{0.03}Ca_{1.97})$ $(Fe^{2+}{}_{3.51}Mg_{0.24}Mn_{0.05})$ $(Fe^{3+}{}_{0.81}Al_{0.32}Ti_{0.03}Cr_{0.01})$ $Si_{6.09}Al_{1.91}O_{22}$ $(OH_{1.38}Cl_{0.62})$. This formula corresponds to chlorine-bearing potassian hastingsite (Leake 1978).

Significant variations in silica (36.40–41.02%) and alumina (8.47–12.63%) contents in one of the samples (No. 5) correspond to a range in composition from ferroedenitic hornblende through hastingsitic hornblende to hastingsite (Leake 1978). The lowest chlorine concentration observed (1.15%) occurs in a ferroedenitic hornblende.

Published data on the composition of amphiboles containing significant concentrations of chlorine are relatively scarce. Four analyzed ferrohastingsites from the younger granites of Nigeria (Borley 1962) contain between 0.66 to 1.98% Cl. Chlorine content of seven hastingsites and magnesian hastingsites in granitic rocks from the northwest Adirondacks (Buddington & Leonard 1953) range from 0.26 to 0.77% Cl. Chlorine content of nine ferroan pargasites and magnesian hastingsites in charnockitic rocks from Kondapalli, India range between 0.13 and 1.12% (Leelanandam 1970). A hastingsite from an amphibole-rich skarn described by Krutov (1936) is reported to contain 7.24% Cl and no F. Thus, it seems that chlorine occurs in significant amounts more commonly in hastingsites than in other types of amphiboles.

The chlorine content of the hastingsite from this locality suggests that chlorine may have been an important constituent of the metasomatic fluid that attended skarn formation and sphalerite deposition.

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References

Bence, A. E. & Albee, A. L. (1968): Empirical correction factors for the electron microanalysis of silicates and oxides. *J. Geol.* **76**, 382-403.

Borley, G. D. (1962): Amphiboles from the younger granites of Nigeria. I. Chemical classification. *Mineral. Mag.* **33**, 358-376.

Buddington, A. F. & Leonard, B. F. (1953): Chemical petrology and mineralogy of hornblendes in northwest Adirondack granitic rocks. *Amer. Mineral.* **38**, 891-902.

Evans, B. W., Shaw, D. M. & Haughton, D. R. (1969): Scapolite stoichiometry. *Contr. Mineral. Petrology* **24**, 293-305.

Krutov, G. A. (1936). Dashkessanite–a new chlorine amphibole of the hastingsite group. *Dokl. Akad. Nauk S.S.S.R.* (Geol. Ser.) 341-373, [in Russ.; *Mineral. Abstr.* **6**, 438 (1937)].

Leake, B. E. (1978): Nomenclature of amphiboles. *Can. Mineral.* **16**, 501-520.

Leelanandam, C. (1970). Chemical mineralogy of hornblendes and biotites from the charnockitic rocks of Kondapalli, India. *J. Petrology* **11**, 475-505.

Shapiro, L. & Brannock, W. W. (1962). Rapid analysis of silicate, carbonate, and phosphate rocks. *U.S. Geol. Surv. Bull.* 1144, A1-A56.

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