Acknowledgements

References

Hawthorne, F. C. (1976) The crystal chemistry of the amphiboles: V. The structure and chemistry of arfvedsonite. *Can. Mineral.*, 14, 346–56.

Hawthorne, F. C. (1981) Crystal chemistry of the amphiboles. In *Amphiboles and other hydrous pyriboles, mineralogy* (P. Ribbe, ed.) *Reviews of Mineralogy* 9A. Min. Soc. Amer.

Hawthorne, F. C. (1983) The crystal chemistry of the amphiboles. *Can. Mineral.* 21, 173–480.

Hawthorne, F. C. and Grundy, H. D. (1977) The crystal structure and site-chemistry of a zincian tirodite by least-squares refinement of X-ray and Mössbauer data. *Can. Mineral.*, 15, 309–20.

Holtstam, D. (1992) Hydrothermal synthesis of manganese-richterite and the Mg/Mn-substitution of richteritic amphiboles. *Neues Jahrb. Mineral., Mh.*, 241–50.

Leake, B. E. (1978) Nomenclature of amphiboles. *Amer. Mineral.*, 63, 1023–52.

Nambu, M., Tanida, K. and Kitamura, T. (1969) Kozulite, a new alkali amphibole from Tanohata Mine, Iwate Prefecture, Japan. *Amer. Mineral.*, 55, 1815 (Abst.).

Skogby, H. and Annersten, H. (1985) Temperature dependent Mg-Fe-cation distribution in actinolite-tremolite. *Neues Jahrb. Mineral., Mh.*, 193-303.

Sundius, N. (1945) The position of the richterite in the amphibole group. *Geol. Fören. Stock. Förh.*, 67, 266-70.

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Hancockite from Jakobsberg, Filipstad, Sweden: the second world occurrence

HANCOCKITE, $CaPbAl_2Fe(SiO_4)_3(OH)$, the plumboan member of the epidote group is to date only reported from its type locality at Franklin, New Jersey (Penfield and Warren, 1899), where it appears in a rather restricted part of the mine, but locally in abundance, associated with andradite, franklinite, manganaxinite, willemite, barite and other minerals (Palache, 1935; Dunn, 1985). [The 'hancockite' reported by Neumann (1985) from Vestpolltind, Lofoten, Norway, does not qualify for the name as it is too low in Pb ($\sim$10% PbO).] During the examination of newly collected dump samples from the early Proterozoic Jakobsberg manganese–iron oxide deposit in the Filipstad district, Sweden (Lat. 59.83°N, Long. 14.11°E), a new hancockite-bearing paragenesis was found. The small deposit, mined mainly during the last century, consists of separate hematite and hausmannite ore bodies in association with silicate reaction skarns, enclosed by dolomitic marble. Like its more famous mineralogical counterpart, the Långban deposit (Moore, 1970), situated in the same district, is believed to result

TABLE 1. Microprobe analyses of hancockite and coexisting minerals.

	hancockite		melanotekite	andradite	hematite
SiO_2	27.48	(27.15-27.94)	16.59	35.27	0.00
TiO_2	0.10	(0.05-0.17)	0.90	0.61	1.08
Al_2O_3	14.52	(14.28-14.83)	0.57	1.83	0.00
Fe_2O_3	13.09	(12.55-13.49)	19.21	27.86	98.28
MnO	0.19	(0.12-0.30)	0.39	3.28	0.18
MgO	0.00	(0.00-0.02)	0.10	0.00	0.12
CaO	9.20	(9.04-9.34)	0.00	30.77	0.00
BaO	0.32	(0.24-0.54)	0.00	0.00	0.00
PbO	32.44	(31.91-32.90)	62.38	0.00	0.00
Total	97.34		100.14	99.62	99.66

Formula proportions *

Charges	25		18	24	6
Si	3.00		2.00	2.98	0.00
Ti	0.01		0.08	0.04	0.02
Al	1.87		0.08	0.18	0.00
Fe^{3+}	1.08		1.75	1.77	1.96
Mn	0.02		0.04	0.23	0.00
Mg	0.00		0.02	0.00	0.01
Ca	1.07		0.00	2.79	0.00
Ba	0.01		0.00	0.00	0.00
Pb	0.95		2.03	0.00	0.00
Sum cations	8.01		6.00	7.99	1.99

*Formula proportions are based on the number of negative charges indicated.

from metamorphism of exhalative-sedimentary deposited, carbonate-hosted Mn-Fe(-Ba-Pb) protores.

Hancockite appears as subhedral, partly hollow grains ('trabecular' or 'atoll' in texture), up to 0.4 mm wide and of a yellow–green colour. For the most part, they occur in contact with melanotekite and hematite grains, and occasionally with garnet. Commonly it appears in marginal parts of intimate hematite/melanotekite aggregates, in some cases completely surrounding them. Minor macedonite has been observed as rims or minute crack-fillings in hematite. The constituents of the rock matrix are medium-grained clinopyroxene, feldspar, and phlogopite, together with subordinate amounts of calcite and barite. The hematite-melanotekite–garnet–hancockite assemblage is concentrated in cm-sized clusters distributed irregularly in the rock. The pyroxene, appearing as pale brownish subhedral crystals, is an aegirine-augite. Feldspar, of approximate composition $Or_{50}Cn_{40}Ab_{10}$ (hyalophane), is to a large extent altered to fine-grained muscovite and cymrite. Samples of a rock with similar appearance cut by up to 10 mm-thick veinlets consisting of cymrite, muscovite and relict hyalophane have also been found. It is interesting to note that the cymrite has no fluorescent response under short-wave UV radiation, in contrast to Långban material, which fluoresces green/bluish white.

Hancockite and some coexisting phases have been analysed chemically with a Cameca SX50 microprobe, operated at 20 kV and 12 nA, and using natural and synthetic standards: vanadinite (Pb$M\beta$), barite (Ba$L\alpha$), strontianite (Sr$L\alpha$), pyrophanite (Mn,Ti$K\alpha$), hematite (Fe$K\alpha$), sphalerite (Zn$K\alpha$), eskolaite (Cr$K\alpha$), periclase (Mg$K\alpha$), corundum (Al$K\alpha$), and wollastonite (Ca,Si$K\alpha$). Sr, Zn, and Cr were below the detection limit in all cases. The data given in Table 1 represent an

average of 10 analyses over two grains (hancockite) or duplicate analyses on a single grain (other minerals). The narrow analytical ranges obtained for hancockite indicate that the mineral is fairly homogeneous. From the calculated formula (Table 1), the epidote under study approaches the idealized end-member $CaPbAl_2Fe(SiO_4)_3(OH)$. In the analytical data of Franklin hancockites given by Dunn (1985), the most lead-rich sample contains only 0.80 Pb p.f.u. The crystal-chemistry of the epidote group, revealed by many detailed X-ray investigations, including some of hancockite (Dollase, 1971) and of strontian members of the group (Catti et al., 1989; Bonazzi et al., 1990) is the basis for the assumed end-member composition. The larger cation(s) is almost entirely confined to the $A(2)$ site of the epidote structure, whereas the less flexible $A(1)$ contains Ca and minor Mn^{2+}. Al is distributed over the three different octahedral sites with the preference $M(2) \gg M(1) > M(3)$. Members with Fe much above 1 atom p.f.u. are rare (Deer et al., 1986). Melanotekite is enriched in Ti relative to the coexisting silicates, evidently through the substitution $M^{2+} + Ti^{4+} = 2\ Fe^{3+}$ (noted for hematite also). The garnet has a high iron content ($X_{Fe} = 0.91$) and is essentially an andradite with approx. 10 mol.% spessartine in solid solution.

Hancockite is markedly pleochroic, with X colourless, Y yellow, Z green, i.e. much the same scheme as for epidote sensu stricto, but quite different from the Franklin variety where some trivalent manganese is believed to give rise to the reddish colour of the mineral (Dunn, 1985). The birefringence is estimated at 0.05, a somewhat higher value than for Franklin hancockite (Palache, 1935).

The find adds a new mineral to the list of lead silicates from Jakobsberg (the first hydrous one), which includes at least six other species: melanotekite, kentrolite, ganomalite, margarosanite, barysilite, and nasonite (the last-mentioned species has recently been identified by U. Hålenius, pers. comm., 1992). Although the present data do not allow any definite conclusions regarding the paragenetical relations between hancockite and associated minerals, we suggest that the formation of hancockite took place after the peak metamorphic events of the district and the main skarn-forming processes, under the influence of hydrothermal fluids, possibly coevally with the breakdown of the K-Ba feldspar.

References

Bonazzi, P., Menchetti, S. and Palenzona, A. (1990) Strontiopiemontite, a new member of the epidote group, from Val Graveglia, Liguria, Italy. Eur. J. Mineral. 2, 519–23.

Catti, M., Ferraris, G. and Ivaldi, G. (1989) On the crystal chemistry of strontian piemontite with some remarks on the nomenclature of the epidote group. Neues Jahrb. Mineral., Mh., 357–66.

Deer, W. A., Howie, R. A. and Zussman, J. (1986) Rock-forming Minerals. 1B Disilicates and Ring Silicates. Longman Scientific & Technical, 629 pp.

Dollase, W. A. (1972) Refinement of the crystal structures of epidote, allanite and hancockite. Amer. Mineral., 56, 447–64.

Dunn, P. J. (1985) The lead silicates from Franklin, New Jesey: occurrence and composition. Mineral. Mag., 49, 721–7.

Moore, P. B. (1970) Mineralogy & chemistry of Långban-type deposits in Bergslagen, Sweden. Mineral. Record, 1, 154–72.

Neumann, H. (1985) Norges mineraler. Nor. Geol. Undersøk., Skr., 68, 278 pp.

Palache, C. (1935) The minerals of Franklin and Sterling Hill, New Jersey. U.S. Geol. Surv. Prof. Paper, 180, 135 pp.

Penfield, S. L. and Warren, C. H. (1899) Some new minerals from the zinc mines at Franklin, N.J. and note concerning the chemical composition of ganomalite. Amer. J. Sci., 4th ser., 8, 339–53.

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