SHORT COMMUNICATIONS

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Reclassification of blueschist amphiboles from Anglesey, North Wales

BLUESCHIST-FACIES rocks occurring within the Mona Complex of Anglesey, North Wales, form a NE–SW trending belt of schist 20 km long and 5 km wide which crosses the south-east side of the island (the 'Penmynydd Zone of the Aethwy Region' in Greenly's 1919 memoir) (Gibbons and Mann, 1983). These pre-Ordovician Penmynydd rocks consist dominantly of basic and micaceous schists metamorphosed probably in early Cambrian times, although as yet no radiometric age data have been published (see discussion in Gibbons, 1983, 1984).

The blue amphibole was first recognized by Blake (1888) at the now classic locality beneath the Marquis of Anglesey's Column, just east of Llanfairpwllgwyngyll (Grid. ref. SH534 716). However, despite the obvious importance of this much frequented locality in preserving a record of exceptionally old high *P*–low *T* metamorphism, there is confusion over the mineral chemistry of the blueschist amphiboles. This short communication provides a clarification of previous data relevant to the 'Column' blueschist amphiboles and presents new microprobe analyses of both blue and green amphiboles from Blake's original locality.

Using optical methods, both Blake (1888) and Greenly (1919) originally identified the amphibole as glaucophane. Greenly also noted the presence of green 'hornblendic' cores to many of the blue amphiboles (see also photograph and caption in Adye, 1906, p. 39). Holgate (1951) produced a wet chemical analysis of a blue amphibole separate obtained from the Column locality and deduced the amphibole to be an 'outlying member of the crossite group'. He observed the zoning in the amphibole noted by previous workers but believed that the '... *more strongly coloured* (green) *amphibole . . . had apparently differed sufficiently in specific gravity from the more abundant* (blue) *variety to be completely removed during the separation process*'. Holgate's data was reclassified by MacPherson (1983) as magnesio-arfvedsonite using the IMA (1978) classification.

The blueschists from the Column are typically strongly foliated, fine grained amphibole–epidote schists with minor quartz, chlorite, sphene, hematite, and magnetite. The core and rim structure is seen in most amphiboles, and records the replacement of a more calcic green amphibole (core) by a sodic blue amphibole (rim) (fig. 1*a* and *b*). Microprobe work was undertaken on a JEOL JSM 35C scanning electron microscope with LINK 860 energy dispersive microprobe, operating on an 80 second count time with 15 kV accelerating voltage and a beam current of 3×10^{-8} A. The analyses were recalculated using the recently available FORTRAN program for the classification of amphiboles according to the updated IMA (1978) scheme (Rock and Leake, 1983). This recalculation involves

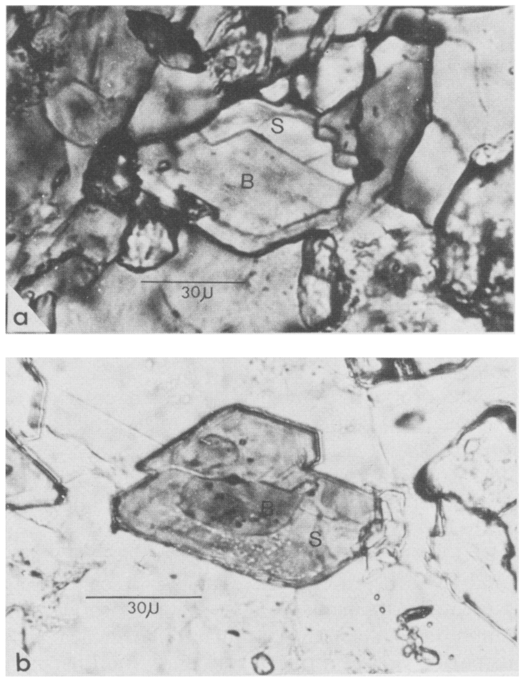

FIG. 1. Photomicrographs of typical zoned amphiboles in the Anglesey blueschists. (*a*) Euhedral core of barroisite (B) rimmed by sodic amphibole of crossite–glaucophane range (S). (*b*) Anhedral core of barroisite (B) enclosed in euhedral sodic amphibole rim (S).

Table I. Typical microprobe analysis of Monument blueschist (B-E) compared with Holgate's 1951 analysis (A). Formula units B-E recalculated using Rock and Leake (1983).

	A	B	C	D	E
SiO_2	50.41	56.32	53.38	56.51	50.23
Al_2O_3	7.82	10.11	10.64	8.04	8.12
TiO_2	1.66	-	0.06	0.01	0.20
Fe_2O_3	8.73	-	-	-	-
FeO	10.81	13.61*	13.04*	14.21*	15.82*
MgO	7.39	9.76	11.39	9.64	11.39
MnO	0.14	0.13	0.14	0.14	0.27
CaO	3.99	2.10	2.13	1.66	7.32
Na_2O	7.04	6.75	5.92	6.18	4.02
K_2O	0.57	0.01	0.04	-	-
H_2O+	1.17	-	-	-	-
H_2O-	0.10	-	-	-	-
	99.83	98.79	96.74	96.39	97.58
Formula Units					
Si	7.25	7.76	7.53	7.95	7.22
Al	1.35	1.64	1.77	1.33	1.37
Ti	0.18	-	-	-	0.02
Fe^{3+}	0.97	0.39	0.88	0.57	0.71
Fe^{2+}	1.33	1.17	0.65	1.10	1.18
Mg	1.63	2.00	2.15	2.02	2.44
Mn	0.00	0.31	-	0.01	0.03
Ca	0.63	1.80	0.32	0.25	1.12
Na	2.00	0.00	1.61	1.68	1.12
K	0.10	0.10	0.00	0.00	0.03
	15.54	15.12	14.95	14.94	15.29

*Total Fe as FeO

A: Holgate 1951, wet chemical analysis - calcio anophorite
B: Microprobe analysis - glaucophane (rim)
C&D: Microprobe analysis - crossite (rim)
E: Microprobe analysis - barroisite (core)

adjustment of the total cations, excluding Ca+Na+K, to 5+8 = 13, by varying the Fe^{2+}/Fe^{3+} ratio.

The probe data reveal the green core to be barroisitic in composition and not hornblendic as previously recorded (Adye, 1906; Greenly, 1919). The sodic amphiboles after recalculation were found to span the crossite–glaucophane field with $Fe^{3+}/(Fe^{3+}+Al^{IV})$ values of 0.22–0.41 and $Mg^{2+}/(Mg^{2+}+Fe^{2+})$ ratios of 0.63–0.78. Typical analyses are presented in Table I. Recalculating Holgate's data using the same method produces an amphibole lying in the calcian anophorite field. The disparity between this result and MacPherson's (1983) magnesio-arfvedsonite is simply due to the reintroduction of anophorite by the IMA for subsilicic (i.e. $\leqslant 7.5$ Si) alkali amphiboles with $Na_B \geqslant 1.34$ and $(Na+K_A) \geqslant 0.5$ (Rock and Leake, 1984).

Closer inspection of the original Holgate analysis shows anomalously high Ca levels (4%). Holgate suggested that either this constituted a new mineral or that some contamination was involved. We would agree with this second proposal and instead interpret his data as a hybrid analysis involving both the barroisitic and crossitic–glaucophanic amphiboles, i.e. Holgate failed to separate out all his 'green core' material from the 'blue rim' amphibole. Whilst the Column blue amphiboles do lie in the crossite–glaucophane range Holgate's crossite analysis is not an accurate representation of their mineral chemistry. In conclusion, our analyses show the amphiboles in the Column blueschists of Anglesey to range in composition between glaucophane and crossite and often preserve cores of dark-green barroisite.

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Chromium-rich kyanite in an eclogite from the Rouergue area, French Massif Central

A CHROMIUM-RICH kyanite with a maximum content of 7% Cr_2O_3 occurs in an eclogite from the leptyno-amphibolic group of Eastern Rouergue, French Massif Central. The leptyno-amphibolic group is a bimodal formation with relict eclogitic parageneses (Nicollet and Leyreloup, 1978) which represents the trace of an ancient suture zone (Bodinier *et al.*, 1985). The studied eclogite sample (Rd 749) comprises a lens 1 m long within a matrix of both amphibolites and metagreywackes. The matrix has suffered the later barrovian type metamorphism related to Variscan thrusting (Burg *et al.*, 1984). In this paper we present mineralogical and chemical data on the high-chromian kyanite in order to discuss the kyanite-forming reaction and inferred *P–T* conditions, with special references to other Cr-kyanite occurrences. Representative microprobe analyses (Table I) have been carried out with a wavelength dispersive Camebax instrument in the University of Montpellier (France).

In the eclogite Rd 749, the high-pressure stage is characterized by the association garnet (gro 24, py 47, alm 28)-omphacite (jad 25)-epidote-kyanite-quartz. The most striking occurrence of garnet is the development of garnet coronas around omphacite, thus giving the eclogite a peculiar honeycomb texture (Lasnier, 1970). Numerous idiomorphic kyanite inclusions (< 0.05 mm) are present in the garnet core whether coronitic textures develop or not. No significant $R^{3+} \rightleftharpoons Al^{3+}$ substitution has been observed in these kyanite grains. Also in the garnet core is a smaller number of large kyanite crystals (up to 0.2 mm); these have been found to be chromian kyanite and show strong blue pleochroism. The crystals (fig. 1) invariably contain inclusions of Cr-rich rutile ($0.47\% < Cr_2O_3 < 0.68\%$). A marked zonation in Cr_2O_3 content is measured in the kyanite, from core (up to 6.99%) to rim (up to 1.1%), the 6.99% maximum being reached around the Cr-rutile inclusions. Fe_2O_3 (up to 0.58%) is the other trivalent ion, with no relation to the Cr_2O_3 content. The increase in Cr_2O_3 content is positively correlated with the blue colour intensity (an observation also made by Sobolev *et al.*, 1968) and it does not seem necessary to imply any other chemical control as charge transfer process (Smith and Strens, 1976) or TiO_2 content (Neiva, 1984).

From a general point of view, the occurrence of kyanite inclusions, both chromian and Cr-free, appears as a major feature of the Rd 749 eclogite. In addition a magnesio-hornblende aggregate is