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Low-iron cordierite in phlogopite schist from White Well, Western Australia

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SUMMARY. Pale-blue cordierite (complete analysis given; shows total iron oxides only 0.98 %) occurs in phlogopite schist near White Well ($24^{\circ} 28' 30''$ S, $116^{\circ} 2'$ E.) 20 miles north-west of Yinnietarra, Western Australia. Associated minerals are corundum, dravite, and sillimanite, accessory zircon and rutile. The cordierite is in translucent masses to $8 \times 8 \times 4$ cm with vitreous lustre, $D = 2.57$, $n_x = 1.536$, $n_y = 1.540$, $n_z = 1.543$, all colourless, $2V_x = 80^{\circ}$. Unit cell $a = 17.055$, $b = 9.724$, $c = 9.350$ Å. The host phlogopite (complete analysis given) is in brown flakes to 1 cm, $D = 2.88$, $\alpha = 1.558$, $\beta = 1.585$, $\gamma = 1.59$, $2V_x = 5-20^{\circ}$, 1M polymorph.

In September 1970 Messrs. Kempton and Kempton of Carnarvon, Western Australia submitted to the Western Australian Government Chemical Laboratories an unusually fresh specimen of pale-blue cordierite for identification. The specimen locality was given as 20 miles north-west of Yinnietarra ($24^{\circ} 32' S.$, $116^{\circ} 9' E.$) three miles south of Mt. Yaragner and one mile north of the south-west end of Lockier Range. No details of host rock or geology of the vicinity were available.

E. Tovey's analysis of purified material (Payne, 1970) showed a lower iron oxide content, 0.86 %, than any analysis tabulated by Deer, Howie, and Zussman (1962).

In September 1971, while collecting in the Yinnietarra area, P. Bridge was taken by R. Williamson, prospector, to a cordierite occurrence in the vicinity of White Well ($24^{\circ} 28' 30''$ S., $116^{\circ} 2'$ E.), probably the same area as the earlier occurrence. A comprehensive suite of cordierite and host rock specimens was thus obtained for the present paper. Type material is preserved at the Government Chemical Laboratories, Perth, Western Australia.

Occurrence. The White Well cordierite is contained in the outcropping rims of two brown phlogopite schist bodies six feet in diameter filled with phlogopite debris. The schist is most likely a metamorphosed ultrabasic and is enclosed in soil-covered Wyloo group sediments close to their contact with an intrusive granite. Associated with the cordierite are white corundum crystals, occasional small dravites, and a little sillimanite with accessory zircon and rutile.

Mineralogy. The cordierite occurs as masses up to $8 \times 8 \times 4$ cm, one a single crystal, showing a few strong pinacoidal and prismatic partings, with some fine sillimanite and mica inclusions. The masses are pale blue, translucent with vitreous lustre, D (sink-float) 2.57 ± 0.01 , refractive indices $n_x = 1.536$, $n_y = 1.540$, $n_z = 1.543$, all colourless, $2V_x = 80 \pm 1^{\circ}$.

Chemistry. The analysis, table I, was performed by well-known methods on a sample $D = 2.57 \pm 0.01$ purified by repeated centrifuging in diluted bromoform to 99.9 %

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purity. Apart from the unusually low total iron oxide, 0.98 %, the analysis is little different from several others tabulated by Deer *et al.* (1962).

X-ray data. A cell-parameter refinement by the method described by Pryce (1970) gave a 17.055 ± 0.005 Å, b 9.724 ± 0.001 Å, c 9.350 ± 0.001 Å, $a:b:c$ 1.7549:1.0:0.9615.

TABLE I. Chemical analyses of cordierite and phlogopite from White Well. Analyst E. J. Tovey

	A	B		A'	B'	
SiO ₂	50.2	38.8	Si	20.09	24.00	5.497
Al ₂ O ₃	33.5	21.7	Al	3.91		2.503
			Al	11.89	11.93	1.120
Fe ₂ O ₃	0.14	0.98	Fe ³⁺	0.04		0.105
FeO	0.84	0.94	Fe ²⁺	0.28		0.112
MgO	12.8	21.0	Mg	7.63		4.433
MnO	0.06	0.02	Mn ²⁺	0.02		0.003
TiO ₂	< 0.01	0.15	Ti	—		0.016
P ₂ O ₅	< 0.01	0.07	P	—		0.008
CaO	0.23	1.10	Ca	0.10		0.168
K ₂ O	0.14	10.5	K	0.08	12.71	1.892
Na ₂ O	0.26	1.03	Na	0.10		0.281
Li ₂ O	nd	0.01	Li	—		0.005
Cr ₂ O ₃	nd	< 0.01	—	—		—
V ₂ O ₅	nd	< 0.01	—	—		—
B ₂ O ₃	nd	0.04	Ba	—		0.003
H ₂ O ⁺	1.69	3.07	H	4.50		OH 2.898
H ₂ O ⁻	0.12	0.49	—	—		—
F	nd	0.23	F	—		0.102
Σ	99.98	100.13	O	74.36		21.000
Less O = F		0.09				
Σ		100.04				

nd = not determined

A Cordierite, Laboratory No. 4051/1972

B Phlogopite, Laboratory No. 4052/1972

A' Cordierite, empirical unit cell content

B' Phlogopite, atomic ratios based on 24(O, OH, F)

$V = 1550.6 \text{ \AA}^3$. The X-ray powder data show close correlation with P.D.F. card 13-294, low-cordierite, the work of Schreyer and Schairer in 1961 on artificial pure magnesium cordierite. For the White Well cordierite the calculated distortion index of Miyashiro as described by Deer *et al.* (1962) is 0.28, placing it near the upper limit of Miyashiro's subdistortional cordierite range.

The *phlogopite* is in schistose layers of brown flakes up to 1 cm across with $D(\text{sink-float})$ 2.88 ± 0.01 , α 1.558, β 1.585, γ 1.59, $2V_0$ 5–20°. The analysis, table I, was performed mainly by well-known methods on a pure sample, $D = 2.88 \pm 0.01$ prepared by hand picking. Fluorine was determined by the specific ion electrode method described by Ingram (1970). The analysis figures are comparable with several phlogopite analyses tabulated by Deer *et al.* (1962). Powder X-ray films gave very

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similar results to P.D.F. data card 10-495, the work of Smith and Yoder in 1956 for a 1M phlogopite, Weissenberg films confirmed that 1M was the only polymorph present in White Well phlogopite.

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