Graduate School with funds from the Wisconsin Alumni Research Foundation and in part by facilities grant G13793-Jackson from the National Science Foundation. The authors thank Professor P. J. Kaesberg of the Department of Biochemistry for permission to use the electron microscope.

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THE AMERICAN MINERALOGIST, VOL. 50, JULY-AUGUST, 1965

A CORDIERITE-RICH MAGNETITE-HÖGBOMITE-ORTHOPYROXENE HORNFELS FROM CURRYWONGAUN, CONNEMARA, IRELAND

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During recent re-mapping of the Currywongaun noritic intrusion (Ingold, 1937), North Connemara, Co. Galway, Ireland, by Dr. N. S. Angus, an interesting hornfelsed pelitic xenolith, largely composed of partly pinitised cordierite, with lesser magnetite and accessory högbomite, orthopyroxene and biotite was discovered. The nearest exposure of basic rock is about 10 yds away, but the contact of the two rocks is not exposed. The xenolith is about 30 yds from the inferred edge of the intrusion, which is intruded into a series of pelitic and semipelitic sillimanite-garnet-staurolite-bearing schists.

The rock has an almost equigranular texture dominated by cordierites which average 1–2mm in mean diameter. The cordierite only rarely shows lamellar twinning. The magnetite has grown along the cordierite grain boundaries and frequently presents concave surfaces to the cordierite.

Pinitisation along the cordierite grain boundaries and cleavages has produced a network, mostly of green chlorite, though some kaolinite and montmorillonite may also be present. Despite this pinitic alteration the cordierite is exceptionally fresh compared with cordierite from most Connemara localities. Thin replacement chlorite veins also corrode the magnetite. Both the högbomite and the trace of pyrite, which is present, are invariably associated with the magnetite and the minute (0.05mm) högbomite grains seem to grade into the magnetite. The högbomite is dichroic in shades of deep dark brown. The biotite generally appears to be partly replaced by the cordierite, as is usual in cordierite-rich hornfelses, but a few of the rare orthopyroxenes are thinly sheathed by biotite rims which appear to marginally replace the pyroxene.

TABLE 1. CHEMICAL ANALYSES OF THE HORNFELS AND ITS CORDIERITE

	1	2	3			4	
SiO_2	37.10	48.58	Si	4.98	6.00	Cordierite	70.9
Al_2O_3	27.45	31.21	Al	1.02		Pinite	18.7
TiO_2	1.14	0.02	Al	2.75	2.83	Magnetite	8.8
Fe_2O_3	10.22	1.04	Ti	0.00		Högbomite	0.6
FeO	10.07	3.90	Fe^3	0.08		Biotite	0.3
MgO	9.70	12.00	Fe^2	0.33	2.33	Orthopyroxene	0.1
CaO	0.20	0.07	Mn	0.01			
Na_2O	0.37	0.56	Mg	1.85			
K_2O	0.30	0.20	Ca	0.01			
MnO	0.13	0.10	Na	0.11			
P_2O_5	0.02	0.03	K	0.02			
H_2O^+	3.12	2.10					
	99.82	99.81					

1. Cordierite-rich pinite magnetite högbomite-biotite-orthopyroxene hornfels (BL 3386) from 690 yds N. of the northern point of Lough Touther, *i.e.* about 780 yds NE. of Currywongaun 901 triangulation point, 6 in. sheet 10, Co. Galway. Analyst, A. Kemp.
2. Cordierite from BL 3386, α 1.538, γ 1.548, $2V_\alpha$ $85\pm3°$. Analyst, A. Kemp.
3. Cations, on the basis of 18 oxygens, of the cordierite.
4. Modal analysis, in volume percent, of BL 3386 hornfels.

Chemical and modal analyses of the hornfels are given in Table 1. Compared with unhornfelsed Connemara pelites (Leake, 1958) the rock has clearly suffered appreciable loss of silica and alumina, prominent loss of both alkalies and some oxidation of the iron. This probably occurred as granite or syenite-forming constituents were melted out of the xenolith and this process has been fully described by Evans (1964) and Leake and Skirrow (1960).

Chemical analysis of the cordierite and its optical properties are also given in Table 1. The number of cations on the basis of 18 oxygens suggests that the cordierite may be a little low in alumina and high in magnesia though a third analysis of these oxides gave similar figures to the duplicates previously obtained so that any error is a systematic one. A closely similar analysis has been published by Tilley (1940, p. 340). The total cations have an excellent sum of 11.16. The cordierite is magnesium-rich but not particularly so, as the $MgO/MgO+FeO+MnO+Fe_2O_3$ ratio of 0.82 is exceeded by at least 11 other published cordierite analyses (Barker 1964a, 1964b; Iiyama, 1960; Leake, 1960). The distortion index, Δ (Miyashiro, 1957), of the cordierite is 0.25, which is within the range of typical metamorphic cordierites. After heating to 960° C. for two hours, Δ increased to 0.27, which agrees with a subdistortional cordierite.

The associated orthopyroxene has $2V\alpha$ near to 100° with γ below 1.70, suggesting a composition of En_{91}. Partial analysis of the magnetite contaminated with a few per cent of cordierite and högbomite gave 58.80% Fe_2O_3, 30.70% FeO, 2.17% Al_2O_3, 1.30% TiO_2 and 0.04% MnO. If the cordierite and högbomite are allowed for, there cannot be more than a very little alumina and probably about 1% titania in the iron ore, indicating a moderately pure magnetite. Knowing the composition of the cordierite and the approximate composition of the magnetite and orthopyroxene enables an estimate of the bulk composition of the pinite to be made. This agrees with a possible mixture of aluminous chlorite, montmorillonite and kaolinite. The alkali content of the rock is much too low for sericite or paragonite to be present.

Following the initial discovery by B. W. Evans of högbomite in the strongly desilicated pelitic xenoliths of the Cashel intrusion, Connemara, högbomite has been found to be common in very small amounts (*ca.* 0.01%) in many of the corundum, spinel and magnetite bearing xenoliths. Thus the assemblages green spinel-cordierite-magnetite-biotite-En_{93} orthopyroxene-högbomite and magnetite-spinel-saussurite-biotite-cordierite högbomite (Specimens 1470 and 1460A, Leake and Skirrow, 1960, p. 31) are known as well as corundum-magnetite-ilmenite-spinel-högbomite (with chlorite) recorded by McKie (1963, p. 565). One specimen (BL 1738) containing about $\frac{1}{2}$% högbomite has iron ore filled corundum-magnetite-green spinel clots in a cordierite-andesine-biotite rock. The högbomite often rims the edge of the magnetite, is between magnetite and corundum or between spinel and magnetite as well as being in the magnetite itself. These associations have been frequently noted elsewhere in various högbomite occurrences (McKie, 1963, p. 577). All these assemblages differ from the examined Currywongaun hornfels in that neither green spinel nor corundum are present in this rock. Hercynite and pleonaste cannot be assumed to be in solid solution in the magnetite for the chemical analysis shows that this is not so. Moreover, the presence of högbomite cannot be ascribed to a high titania content in the rock because the rock is quite poor in titania (1.14%), compared with the previously analysed slightly desilicated Connemara pelitic hornfelses. Thus the average titania of 11 hornfelses with more than 30% silica (Evans, 1964) is 1.95, the lowest value being 1.24%. Although högbomite is undoubtedly at least partly a secondary phase in most of the Connemara occurrences noted above, it is uncertain whether the högbomite is a primary or secondary phase in the Currywongaun hornfels. Although it grades into the magnetite and is invariably associated with the magnetite, which suggests a secondary origin, it neither rims the iron oren or is restricted to its edge, having textures quite unlike those described by Friedman (1952, p. 603) for secondary högbomite from New York, Virginia and North Carolina. As very little subsolidus work on the FeO-MgO-Al_2O_3-TiO_2 system has yet been carried out the conditions under which högbomite crystallises are unknown and no further comment is possible.

I wish to thank Dr. Angus for kindly supplying the analysed specimen, Mr. A. Kemp for carrying out the chemical analyses and Mr. R. Bradshaw for the *x*-ray analyses.

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