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The Inishdawros meta-peridotite, Callow, Ballyconneely, Connemara, Western Ireland

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SUMMARY. The chemistry and petrography of a meta-ultrabasic lens containing peridotite with poikilitic pyroxenes and hornblende, both of probable igneous origin, are given. The body also contains feldspathic-bearing hornblende meta-gabbros and is a tectonic fragment in hornblende–plagioclase rock belonging to the same Errismore intrusion. Chemical analyses fail to discern any appreciable systematic differentiation trend across the body despite modal variation to hornblende plagioclase layers. The high Niggli mg near the structural bottom of the intrusion suggests that this part of the Errismore intrusion is right way up, contrary to a previous suggestion.

THE Errismore metamorphosed basic and ultrabasic intrusion (Leake, 1970) forms most of the ground west, south-west, and south of Ballyconneely, Connemara (fig. 1) and contains a complex mixture of meta-gabbroic rocks with rare meta-peridotite at Inishdawros. The contacts of this 1 km × 20–100 m meta-peridotite lens appears to be tectonic with marginal shear zones and torn off subsidiary lenses 30–100 m long and 5–10 m wide being common on the SE. side (fig. 1). Apart from a mention by Leake (1970) there is no published account of the body, which is partly mapped on 1 inch geological Map 103 (Slyne Head) of the Geological Survey of Ireland, published about 1870.

As part of a detailed investigation of the Errismore intrusion, the Inishdawros meta-peridotite has been chemically examined in order to determine whether systematic chemical variation exists across the body revealing which way up the lens is or whether the lens is isoclinally folded back on itself, because recumbent isoclinal folds occur in the centre of the lens, suggesting that tight folding is a possibility. Accordingly, samples have been examined from across the body from the structural bottom in the NE. to the structural top in the SW. The position of this meta-peridotite is particularly important in view of unproved suggestions (Leake, 1970) that the Errismore intrusion is inverted with the original igneous top now downward facing and younging towards the Ballyconneely amphibolite of the Delaney Dome (fig. 1). As the Inishdawros lens is near to the possible top of the Errismore body its way up could be critical evidence for or against the inversion hypothesis. Even if the way-up cannot be established within the body itself, the very existence of peridotite so near to the supposed igneous top conflicts with the inversion hypothesis unless the body contains unusually iron-rich assemblages.

Results

Petrographic notes on the analysed rocks are given in the explanation to Table I and only a general summary is needed. The metamorphosed poikilitic peridotite has variably serpentinized Fo_{89-84} (determined by XRD) olivines enclosed in poikilitic orthopyroxene, diopsidic augite, pale brownish hornblende, and, in an unanalysed specimen (BL 364), poikilitic plagioclase, with variable amounts of saussuritized plagioclase that often contains droplets of pale brownish and greenish secondary spinel and symplectic colourless clino-amphibole. The olivine often has a radial fringe of apparently tremolitic amphibole where olivine adjoins plagioclase. The nearly euhedral shape of some of the olivines enclosed in the pyroxenes and hornblende is strong evidence that both pyroxenes and hornblende were igneous minerals even though metamorphic hornblende is definitely present, as for instance replacing augite. Not all the olivine is euhedral and some replacement by both pyroxene and hornblende is evident. Corroded pale-green primary spinel is occasionally present but alteration to chlorite, serpentine, talc, and saussurite is so common that the full range of original igneous variation is not certain. More feldspathic rocks, some lacking olivine, also occur, including patches

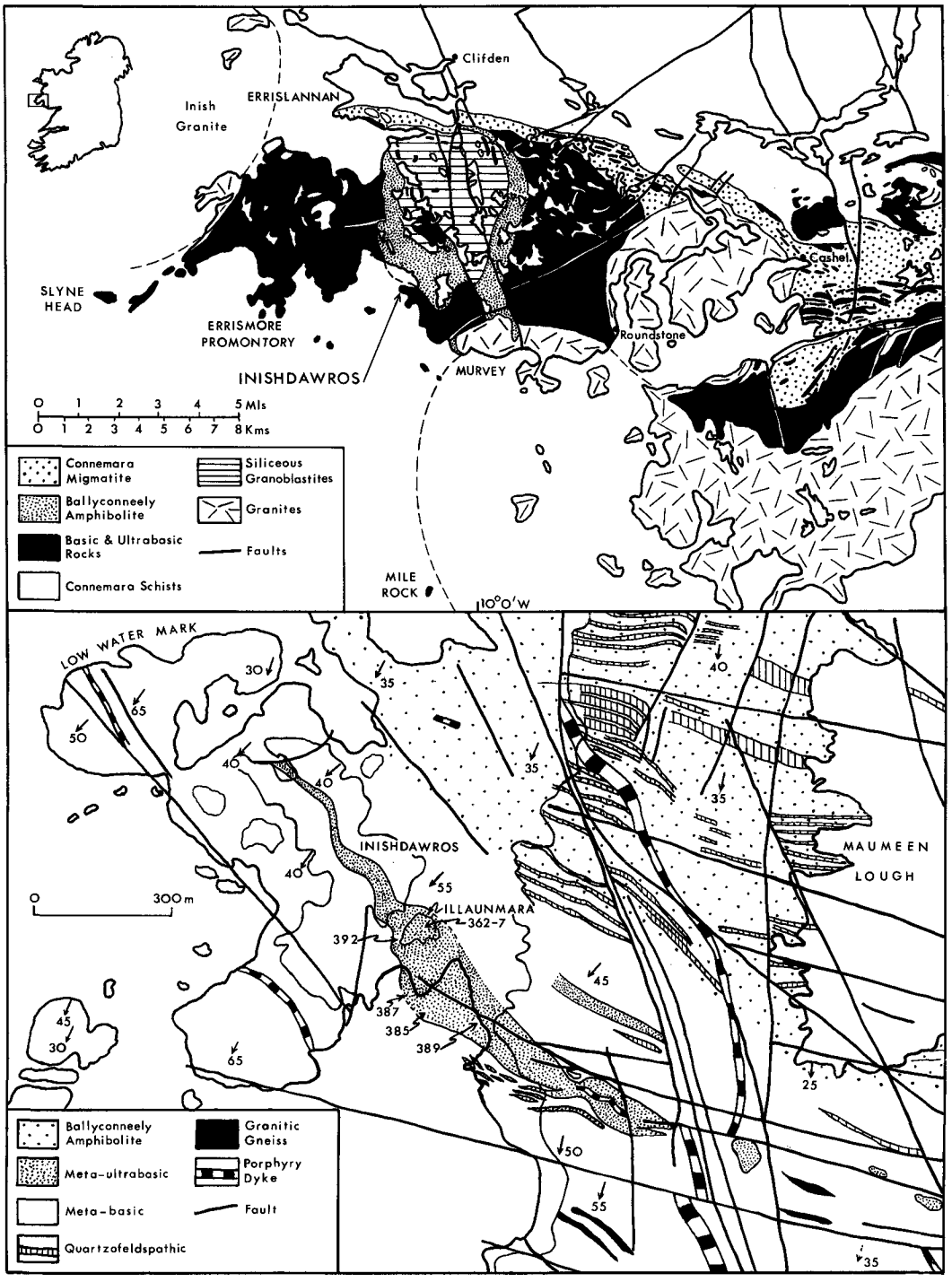


FIG. 1. The geological setting of the Inishdawros body as part of the Errismore intrusion. The lower figure shows the sample locations and the lens shape of the Inishdawros ultrabasic body. Mapped by B. E. Leake.

of pegmatitic hornblende–plagioclase clots near the centre of the lens. Forty metres SE. of Illaunamara a NE.-striking discordant quartz–plagioclase pegmatite vein crosses the peridotite emphasizing the petrogenetic link between the enclosing basic and ultrabasic rocks and the meta-peridotite lens for such quartz–plagioclase matter is a common ingredient of the Errismore intrusion. Occasionally more feldspathic layers in the intrusion inject adjoining mafic-rich parts, presumably due to squeezing of the intrusion before it was completely solid when the mafic-rich parts would be more rigid and consolidated than the more feldspathic material.

Particularly interesting are thin (5 to 20 cm) fine-grained (< 0·5 mm) hornblende saussuritized plagioclase veins that cross the ultrabasic rocks, especially the feldspathic varieties, being similar to the basic veins recorded by Leake (1958, p. 172) as crossing the Cashel intrusion except that all the Inishdawros veins thin sectioned have a metamorphic fabric, whereas many of those at Cashel possess igneous and metamorphic textures. These veins are believed to be the basic equivalents of the acidic aplites commonly found in granitic rocks, and like these aplites, were formed by flowage of residual magma in the host rock into cracks opened in the last stages of cooling. Metamorphism has obviously affected them just as it has all the rocks in the district.

Thorough metamorphism has generally destroyed both the original pyroxenes in the intrusion and the igneous textures, but the existence of definite poikilitic igneous hornblende, identical in texture to the poikilitic clinopyroxene, orthopyroxene, and plagioclase and like those minerals enclosing sometimes near-euhedral olivine or, like the pyroxenes, enclosing sometimes near-euhedral plagioclase, indicates that the igneous crystallization passed into the hornblende stability field. Presumably continued cooling under high-grade metamorphism resulted in widespread amphibolitization of the rocks so that there is both metamorphic and igneous hornblende and exact distinction between the two varieties is not always possible.

The chemical analyses were by wet silicate methods for major elements and by emission spectroscopy for trace elements. The geochemistry shows typical igneous fractionation as measured by variation of Niggli mg against si, fm, ti, alk, c, Ni ppm, and Cr ppm (fig. 2). There is clearly a correlation of normative olivine with Ni, Cr, and Co (fig. 3), presumably due to preferential incorporation of Ni, Co, and Cr into the olivine and the association of Cr-containing spinel with olivine. However, it is notable that although sample BL 392, from within a few metres of the structural top of the peridotite (i.e. near the SW. contact), has Fo_{84} compared with Fo_{89} in BL 363 near to the bottom, the rock is no more differentiated as regards Niggli mg, Cr, Ni, or Co than samples BL 362, 363, or 367 from near to the structural bottom. Accordingly, either the peridotite is a tectonic fragment that is not sufficiently thick to include detectable differentiation, or the body is isoclinally folded back on itself with early differentiates at both margins. This latter view is suggested by tight recumbent folds in the centre of the lens as seen on the rocks exposed below the high-water mark on the mainland SE. of Illaunamara. However, the folding hypothesis is not confirmed by BL 389, which occurs in almost the exact centre of the lens, because BL 389 is no more differentiated than the samples obtained from near to the margins. Accordingly, although the isoclinal fold hypothesis is still feasible, it seems more probable that the body is a simple tectonic fragment torn off a peridotitic gabbro layer in the Errismore intrusion.

The trace- and major-element variation shown in fig. 2 is not entirely a function of differentiation stage but is also critically dependent upon the differing original mineralogies of the rocks. Thus BL 365 and 385 are richest in Al because of increased modal feldspar and these samples also have markedly lower Niggli mg (0·65 and 0·52) compared with the peridotites (mg 0·85–0·86). The Cr, Ni, and Co contents of these two feldspathic samples are so much lower than the remaining samples that even if these elements are normalized in all the samples to the contents appropriate to 50% normative femic minerals following the procedure discussed by Janardhanan and Leake (1975), the feldspathic samples still have very low values for these critical elements. This strongly supports the view that the original femic magmatic minerals differed from those in the peridotite: specifically, they were olivine deficient. This is additional evidence consistent with the presence of original igneous hornblende though admittedly not ruling out derivation from augite. It is puzzling why the feldspathic samples should be intimately associated with mafic-rich rocks and yet have a markedly different mg value, especially as differing oxidation ratios resulting in variable contents of magmatic magnetite is not a possible explanation (BL 365 and 389 have similar oxidation ratios). Certainly merely varying the proportions of feldspar, olivine, and pyroxene would not be adequate. Perhaps BL 365 and 385 have major contents of igneous hornblende that crystallizes with a significantly lower mg value compared with olivine or pyroxene.

TABLE I. *Chemical analyses*

	BL 362	BL 363	BL 365	BL 367	BL 385	BL 387	BL 389	BL 392
SiO_2	38·97	38·13	50·92	38·58	42·39	41·67	40·08	38·73
TiO_2	0·18	0·29	0·40	0·06	2·52	0·63	0·30	0·41
Al_2O_3	5·90	6·23	17·20	6·40	13·33	8·33	9·68	6·00
Fe_2O_3	5·08	4·84	0·49	4·21	4·10	5·73	1·00	4·60
FeO	5·01	5·04	6·04	5·11	9·63	8·61	6·89	5·26
MnO	0·15	0·15	0·19	0·16	0·26	0·16	0·15	0·17
MgO	30·85	31·15	6·93	30·85	8·25	23·10	26·15	31·15
CaO	3·15	4·43	11·42	3·97	14·22	3·80	6·40	5·01
Na_2O	0·00	0·34	3·55	0·26	0·40	0·46	0·38	1·02
K_2O	0·00	0·12	0·68	0·09	0·06	0·06	0·06	0·20
P_2O_5	0·001	0·01	0·16	0·01	0·03	0·05	0·02	0·14
H_2O	9·65	8·71	2·10	9·29	3·95	7·34	8·21	6·78
CO_2	0·62	0·47	0·38	0·41	0·35	0·46	0·41	0·45
Cr_2O_3	0·42	0·42	0·05	0·41	0·02	0·05	0·19	0·47
NiO	0·58	0·16	0·02	0·16	0·03	0·08	0·10	0·16
Total	100·541	100·49	100·53	99·97	99·54	100·53	100·02	100·55
Li ppm	0	4	56	2	10	1	95	15
Rb	n.d.	n.d.	20	1	n.d.	Tr	1	n.d.
Zr	11	26	102	20	70	35	23	16
Co	2077	1432	1	4055	43	329	2861	4285
Sn	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Yb	1	1	3	1	3	2	1	1
Cu	42	68	39	44	252	87	57	97
Zn	n.d.	n.d.	n.d.	23	415	36	110	8
Sc	32	Tr	256	3	201	Tr	Tr	26
V	123	154	242	145	1207	204	178	182
Ba	n.d.	n.d.	402	30	82	39	16	13
mg	0·85	0·85	0·65	0·86	0·52	0·75	0·85	0·85

BL 362. A highly altered peridotite with 2-mm diameter completely serpentinized olivine poikilitically enclosed by diopsidic augite and a little orthopyroxene with magnetite and apatite as accessories and chlorite, talc, serpentine, magnetite, carbonate, and tremolite as secondary minerals. Aggregated bundles of tremolite. North point of Illaunamara, 6 inch Sheet 49, Co. Galway.

BL 363. A moderately fresh peridotite with 2-mm diameter olivine poikilitically enclosed by irregular poikilitic orthopyroxene (up to 26 mm in diameter) and diopsidic augite (up to 14 mm in diameter). Although both pyroxenes partly replace olivine, which is slightly serpentinized, there are many nearly euhedral olivines preserved in pyroxene. Traces of brown and pale-green spinel, both secondary, are present and part of the sample is highly altered to tremolite and chlorite. Rare plagioclase is completely altered to a symplectic mixture of tremolite and saussurite. Location as BL 362.

BL 365. A 5-mm diameter grain-size saussuritized plagioclase (60%) with relict augite (10%) altering marginally to greenish hornblende (25%). Sphene, apatite, iron ore, and clinozoisite are accessories. Location as BL 362.

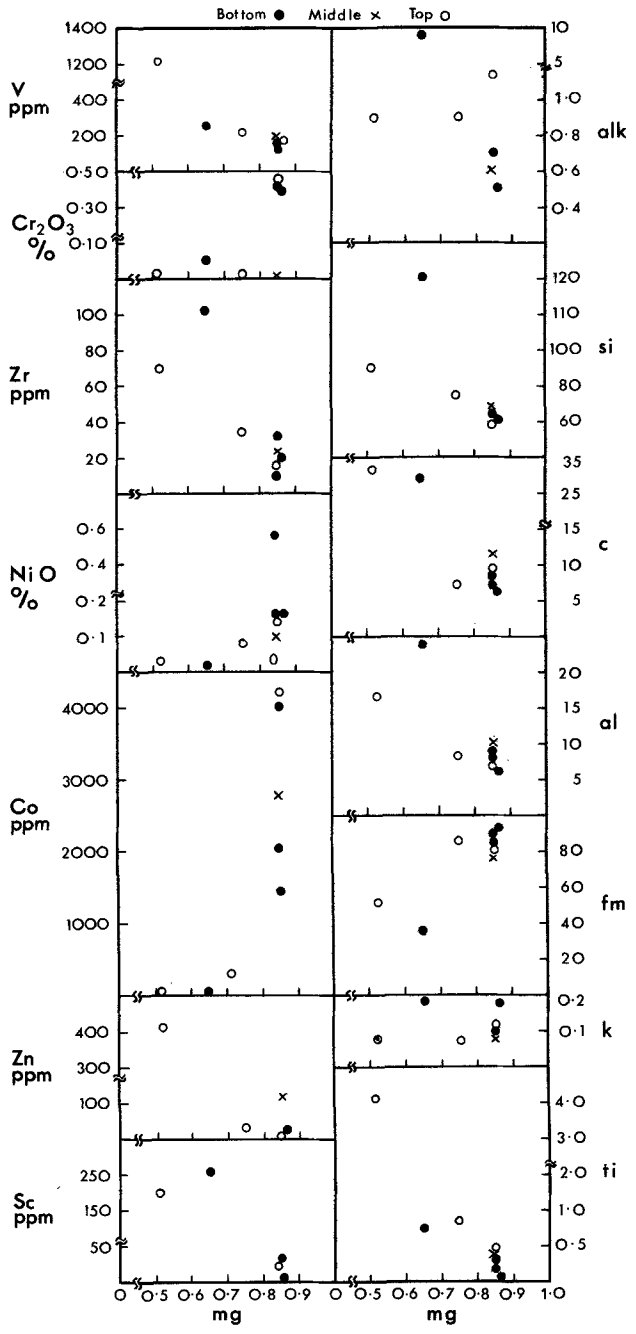
BL 367. Considerably altered peridotite with some relic olivine enclosed in peridotitic altered pyroxene and pale-brownish hornblende. Cummingtonite replacement of olivine which has serpentinous cores. Abundant chlorite outside the serpentinized olivine. Location as BL 362.

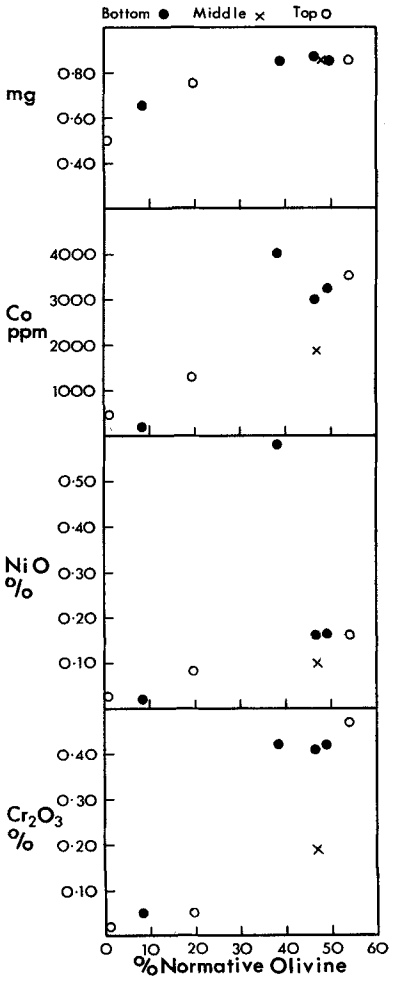
BL 385. About equal amounts of saussuritized plagioclase and hornblende with relic clinopyroxene (6 × 3 mm) cores. A little magnetite. 173 m south of the I of Illaunamara as written on 6 inch Sheet 49, Co. Galway.

BL 387. Altered peridotite with 10–15 mm diameter poikilitic clinopyroxene and smaller hornblendes and rare orthopyroxenes enclosing serpentinized olivines. Phlogopite and talc present. 55 m NW. of a point 173 m S. of the I of Illaunamara as written on 6 inch Sheet 49, Co. Galway.

BL 389. Almost completely altered olivine (2–5 mm) containing serpentine, talc, chlorophaeite, and tremolite amphibole; saussuritized plagioclase and amphibolized augite with interstitial brownish hornblende. Deep-brown spinel droplets. 200 m S. of the last a of Illaunamara as written on 6 inch Sheet 49, Co. Galway.

BL 392. Moderately fresh, 1–2 mm diameter olivine-rich (65%) with enclosing 30% pale-brown poikilitic hornblende in large (*c.* 10 mm) prismatic crystals with a little relict augite altering to hornblende and some plagioclase being replaced by a symplectite mixture of bundles of pale clinoamphibolite prisms with pale-green spinel. Pale-brown spinel is distinct. Serpentine–magnetite veins cross the rock. SW. corner of Illaunamara.





FIGS. 2 and 3: FIG. 2 (*left*). Plots of Niggli mg (= mol MgO/(mol MgO + FeO + $2Fe_2O_3$ + MnO)) against Niggli parameters and trace elements of Inishdawros rocks. FIG. 3 (*right*). Plot of C.I.P.W. normative olivine against mg, Co, NiO, and Cr_2O_3 for Inishdawros rocks.

The surrounding hornblende-plagioclase metabasic rock is mainly distinguished from the metaultrabasic rock by its better foliation, the presence of small amounts of quartz along the foliation, the complete absence of olivine and orthopyroxene, and the general absence of clinopyroxene relics so that the origin of the hornblende in the hornblende-plagioclase rock is uncertain, the rock belonging to the early basic facies of the quartz diorite gneiss as described by Leake (1970).

The meta-peridotite body matches exactly similar lensoid fragments in the Errisbeg part of the intrusion to the east near Roundstone (fig. 1) (Wager, 1932; Morton, 1964; Bremner, unpublished) and is presumably an original layer now disrupted. The lack of evidence of inversion of the Inishdawros lens, the location near to the structural bottom of the intrusion adjoining the Ballyconneely amphibolite, together with the high mg value of the body, is strong evidence against the simple inversion hypothesis previously proposed (Leake, 1970) and must prompt a re-examination of the whole structure of the Errismore intrusion.

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