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Spinels from the Dawros Peridotite, Connemara, Ireland

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SUMMARY. Two different spinels, analyses of which are given, occur in the layered ultramafic rocks at Dawros. Chrome spinel occurs both as gravity-stratified cumulates and as complex orbs, while an Al-rich spinel is both in rocks of the main Dawros magmatic sequence and in an association with an aluminous bronzite, which may originate by recrystallization. It is concluded that while the chrome spinel is certainly of magmatic origin, the aluminous spinel is probably partly of magmatic and partly of recrystallization origin.

Two markedly different spinels occur in the Dawros intrusion (Rothstein, 1957, 1958) of western Ireland (53° 33′ 50″ N, 9° 58′ 0″ W). The first, a chrome-rich variety, occurs principally in a cumulate of olivine (now altered to serpentine) and chrome spinel, associated with Ca-poor and Ca-rich pyroxenes; this spinel is an accessory mineral in many Dawros ultramafic rocks. The second spinel is mainly light green, aluminous, and occurs either with olivine plus diopsidic pyroxene or with aluminous bronzite.

The chrome spinel occurs in cumulates with pronounced gravity stratification, wedge bedding, and evidence of rhythmic precipitation (Rothstein, 1957), with, in one newly described outcrop, a layer of chromite with a complex orbicular texture, consisting of rounded cores of chromite enclosed within larger subhedral olivines (fig. 1). This texture closely resembles the chromites of orbicular and nodular texture found within podiform chromite deposits in alpine-type peridotites (Thayer, 1969). The pyroxenes range up to several cm, are Ca-poor and Ca-rich types with exsolution lamellae of the complementary pyroxene, enclose euhedral chrome spinels, and are intergrown with a little hornblende.

The aluminous spinels are not gravity stratified nor in orbs but mostly occur interstitially in the assemblage olivine+Ca-rich pyroxene suggesting that the spinel may be of late crystallization. Aluminous spinels are often interstitial in alpine-type ultramafic rocks (Irvine, 1967). At Dawros these rocks containing aluminous spinel form part of the main Dawros sequence although the rocks are extensively recrystallized, and their interlocking texture resembles that of the alpine-type peridotite of Burro Mountain, California; that also has undergone a high-temperature recrystallization (Loney, Himmelberg, and Coleman, 1971).

While the foregoing rocks from Dawros are of magmatic origin, the aluminous bronzite+aluminous spinel could be metamorphically recrystallized. Thus at locality M (Rothstein, 1957) layers containing an aluminous Fe-rich bronzite (En_{72}; Al_2O_3

6·02 %) are anomalous in their position in the layered intrusion, being olivine-free and occurring within the recrystallized layered enstatite (En_{91-89}; Al_2O_3 0·7 to 2·3 %) harzburgites of the lower part of the Dawros sequence (Rothstein, 1958).

The chrome spinel (G) from a cumulate was analysed by the Department of Mineralogy, British Museum (Natural History). Unsatisfactory separate values of

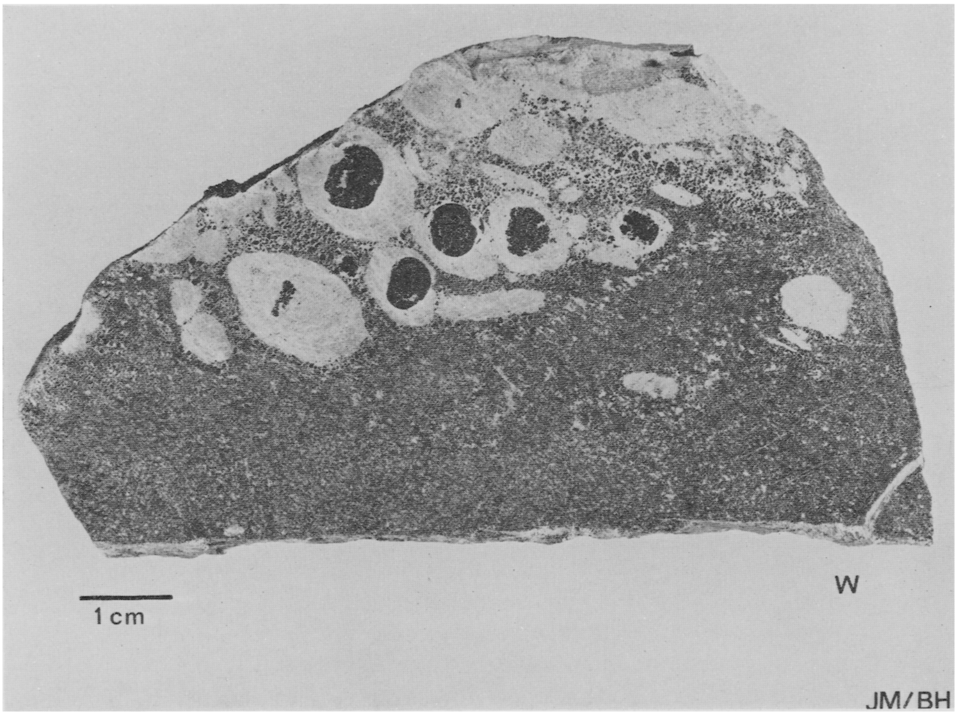

FIG. 1. Orbicular texture of rounded chromite cores enclosed within subhedral olivine (serpentinized) within a chromite-rich cumulate. Section cut in the plane of the layering (50 metres west of Locality G, Rothstein, 1957).

FeO and Fe_2O_3 were obtained, the FeO being too high for the spinel formula. The cell size and density were therefore determined at the Natural History Museum, where, taking these values into account, the analysis was recalculated by adjusting the $Fe^{2+}:Fe^{3+}$ ratio. The analysis is given in Table I, together with that of two previously analysed aluminous spinels (Rothstein, 1962).

The chrome spinel (G) with its high Cr has a markedly different composition from the aluminous spinels (U/V and M), and also in fig. 2 it may be seen that the chrome spinel (G) plots in the area of overlap of the fields of spinels from the alpine-type peridotites and major stratiform complexes (Irvine, 1967). The aluminous spinels plot outside the field of spinels from the alpine-type peridotites, unlike the primary aluminous spinel from the Lizard peridotite, Cornwall (Green, 1964).

The marked differences in texture, composition, and mineral associations of the Dawros spinels suggest differing origins. The chrome spinel is clearly of primary magmatic crystallization as a cumulus phase, and the interstitial spinel (locality U/V) in the assemblage olivine+Ca-rich pyroxene is also probably of magmatic origin, there

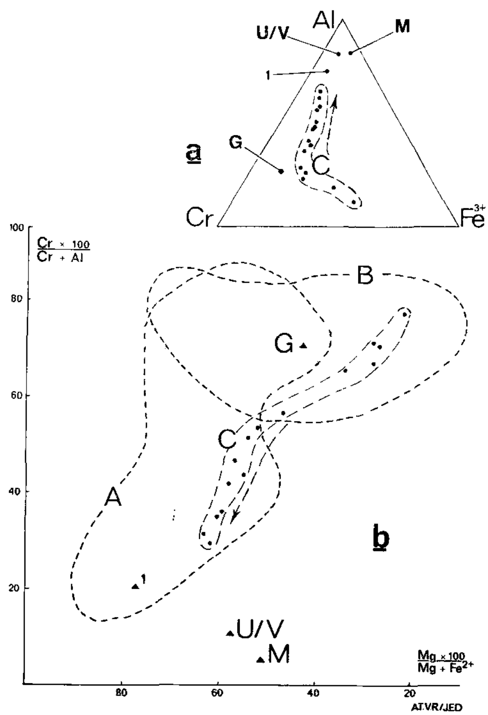

FIG. 2. (a) Plot of the Al:Cr:Fe^{3+} ratios of the analysed spinels G, U/V, and M from Dawros, the primary aluminous spinel (1) from the Lizard (Green, 1964), and the range of spinels (C) from the Rhum ultrabasic intrusion (Henderson and Suddaby, 1971). (b) Plot of the Cr/(Cr+Al) and Mg/(Mg+Fe^{2+}) values of the above spinels with respect to the general fields of spinels from the alpine-type peridotites (A) and major stratiform complexes (B) (Irvine, 1967).

being no sign of the spinel forming from recrystallization processes involving an alumina-rich pyroxene (Green, 1964). But metamorphic reaction may explain the spinel associated with the aluminous bronzite. Although the similarity in composition of the two aluminous spinels of the Dawros intrusion superficially makes it difficult to envisage a wholly different origin for each of them, it is known that similar mineral compositions can arise by different paths. In the Rhum intrusion, Scotland (Henderson and Suddaby, 1971), Al-rich spinels have been generated by the reaction of chromite with olivine, plagioclase, and an interstitial liquid and a similar process might have occurred at Dawros (fig. 2). However, the differences in composition between the two varieties of Dawros spinel are more extreme (e.g. in Ti) than at Rhum, and there is also an absence of partly resorbed chrome-rich spinels. However, this may be due to the extensive recrystallization, which has affected much of the Dawros intrusion. It seems most likely that while the aluminous spinel associated with olivine and Ca-rich pyroxene is principally of magmatic origin, that associated with the aluminous bronzite was formed during the recrystallization of a different primary assemblage.

TABLE I. *Spinel analyses*

	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	V_2O_5	Fe_2O_3	FeO	MnO	CaO	MgO	Sum
G	0·60	0·53	13·10	46·40	0·25	10·00*	20·60*	0·31	0·04	8·40	100·23
U/V	—	—	51·30	9·30	—	6·83	18·87	—	—	14·00	100·30
M	—	tr	51·60	4·30	—	11·20	20·94	0·20	—	12·24	100·48

Cations to 32 oxygens

	G		U/V		M	
Ti	0·106		—		tr	
Al	4·100		13·241		13·426	
Cr	9·730	15·951	1·582	15·955	0·743	16·026
V	0·022		—		—	
Fe^{3+}	1·993		1·132		1·857	
Fe^{2+}	4·562		3·462		3·888	
Mn	0·070	8·028	—	8·030	0·040	7·962
Ca	0·064		—		—	
Mg	3·332		4·568		4·034	

G. Chrome spinel from locality G (Rothstein, 1957) $Cr_{61\cdot5}Al_{25\cdot9}Fe^{3+}_{12\cdot6}$ ($Mg_{42\cdot2}Fe^{2+}_{57\cdot8}$). *Analysis recalculated from total iron expressed as Fe_2O_3 32·90%; a = 8·3081±0·0012 Å, D = 4·65±0·05. Analyst C. J. Elliott, cell size determination Dr. R. J. Davis, Dept. of Mineralogy, British Museum (Natural History). Density value redetermined by Dr. A. C. Norris and J. Fletcher, Department of Chemistry and Geology, Portsmouth Polytechnic.

U/V and M. Aluminous spinel from localities U/V and M (Rothstein, 1957). U/V $Cr_{10}Al_{83}Fe^{3+}_{7}$ ($Mg_{57}Fe^{2+}_{43}$); M $Cr_{4\cdot6}Al_{83\cdot8}Fe^{3+}_{11\cdot6}$($Mg_{51}Fe^{2+}_{49}$). Analyst V. A. Moleva, IGEM, Acad. Sci. USSR (Rothstein, 1962).

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