Rodingite from the Girvan-Ballantrae complex, Ayrshire.

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Occurrence and relationships. Altered and garnetized gabbros occur in association with serpentinite occupying the lower south-eastern slope of Byne Hill, one mile to the south of Girvan. The rocks crop out above Balaclava Wood near the footpath from Bynehill Bridge to Craiglea. Although the precise form of the altered gabbros is not very well revealed, they appear to be dikes intrusive into the surrounding serpentinized harzburgite. Contacts with the serpentinite are exposed in two places but are evidently lines of later movement. The relationships of these altered gabbros to the main gabbro mass of Byne Hill are obscure. They are, however, probably contemporaneous, since sporadic garnetization of the main gabbro occurs along its contact with serpentinite farther to the south-west.

Petrography. The rock is almost pure white and exceedingly tough, with a sharp flinty fracture. Dispersed aggregates of magnetite form the only conspicuous dark mineral. The high density (3·24) of the rock is a characteristic feature and distinguishes it from saussuritized gabbros.

Under the microscope the rock retains its original gabbroidal texture, but the plagioclase has been almost completely replaced by small colourless garnet with subordinate zoisite (fig. 1). The garnet averages 0·01 mm. in size and forms a dense matte rendering the plagioclase pseudomorphs isotropic. The altered plagioclase still preserves good crystal boundaries and is ophitically related to large plates of pyroxene almost completely altered to chlorite (pennine). Prehnite is generally present in the rock and parts of the dike may be almost wholly replaced by prehnite, together with pectolite and calcite.

Analyses. An analysis of a garnetized gabbro from Byne Hill is given in table I, A. This rock contained only minor amounts of prehnite. The most distinctive feature of the analysis is the low silica and high lime. The correspondence, both physically and chemically, with those garnetized gabbros known as 'rodingite' is evident (table I, B and C).

Nature of the garnet. Attempts to separate the garnet from the rock in quantities sufficient and pure enough for chemical analysis were unsuccessful due to the presence of zoisite which appeared to have a rather wide range of density. However, contamination with zoisite was

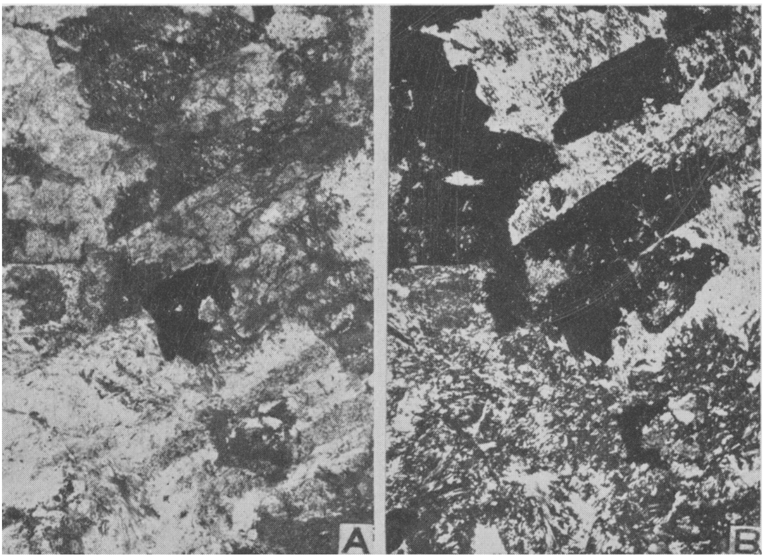

FIG. 1. Garnetized plagioclase and chloritized pyroxene. A large grain of magnetite at the centre. A, ordinary light; B, crossed nicols. ×15.

not serious enough to prevent the determination of the physical properties of the garnet which exhibited a range in density 3·49–3·39 (uncorrected values at room-temperature). Refractive index measurements (Na-light) gave values of 1·742 with sp. gr. 3·49, and 1·718 with sp. gr. 3·39. Garnet with the higher values of density and refractive index is grossular. That with the lower values may be a hydrogarnet of the type described by Hutton (1943) from the New Zealand rodingites.

Origin of the rodingites. The Byne Hill rodingite appears to be identical with those from New Zealand and Western Australia, all of which are associated with ultrabasic rocks. Marshall (1911) regarded the rodingites as primary products of crystallization, while Finlayson (1909) considered that the basic magma had been enriched in lime by the digestion of limestone. Grange (1927) concluded that the rocks were derived by the alteration and metasomatism of gabbros, the garnet being secondary in origin. The source of the lime was ascribed to the serpentinization of lime-bearing pyroxene in the adjacent ultrabasics (Grange, 1927; Miles, 1950; Watson, 1953).

TABLE I. Chemical analyses of rodingite.

	A.	B.	C.
SiO_2	38·04	33·95	40·98
TiO_2	0·82	0·42	1·01
Al_2O_3	15·07	19·91	12·77
Fe_2O_3	1·78	1·28	1·10
FeO	3·02	6·98	4·06
MnO	0·21	0·28	0·16
MgO	9·62	5·23	7·31
CaO	25·84	26·95	29·40
Na_2O	0·18	0·15	nil
K_2O	0·04		0·03
H_2O+ ...	4·19	4·85	2·68
H_2O- ...	1·15		0·31
CO_2	nil	nil	0·07
P_2O_5	0·24	—	0·08
	100·20	100·00	99·96
Sp. gr. ...	3·24	—	3·33

A. Rodingite, Byne Hill, Ayrshire, Anal. W. H. Herdsman.
B. „ Roding river, Dun Mtn., New Zealand. P. Marshall, 1911, p. 33.
C. „ Eulaminna, Western Australia. K. R. Miles, 1950, p. 125.

In addition to garnet, lime-bearing minerals (generally hydrous) include prehnite, pectolite, zoisite, epidote, and diopside (Watson, 1953), all of which are represented in other basic rocks marginal to serpentinite in the Girvan-Ballantrae district. The lime introduced into the Byne Hill rocks cannot have been derived from the serpentinization of the ultrabasics since the latter are dominantly harzburgites (olivine-bronzite). Some lime may have been available from the alteration of pyroxene and plagioclase in the gabbro itself, but would be quite subordinate in amount.

It is concluded that lime-rich hydrothermal solutions and CO_2, which immediately post-dated serpentinization, were responsible for the alteration of the gabbro and also produced local carbonatization ($CaCO_3$) of the serpentinite. Veins of diopside-zoisite traverse the serpentinite in some parts of the Girvan-Ballantrae district and are regarded as products of the same hydrothermal activity (Murgoci, 1900).

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References.

FINLAYSON (A. M.), 1909. The nephrite and magnesian rocks of the South Island of New Zealand. Quart. Journ. Geol. Soc. London, vol. 65, pp. 351–381.

GRANGE (L. I.), 1927. On the 'rodingite' of Nelson. Trans. New Zealand Inst., vol. 58, pp. 160–166.

HUTTON (C. O.), 1943. Hydrogrossular, a new mineral of the garnet–hydrogarnet series. Trans. Roy. Soc. New Zealand, vol. 73, pp. 174–180. [M.A. **9**–61.]

MARSHALL (P.), 1911. The geology of the Dun Mountain subdivision, Nelson. Bull. New Zealand Geol. Surv., no. 12, pp. 31–35.

MILES (K. R.), 1950. Garnetized gabbros from the Eulaminna district, Mt. Margaret goldfield. Bull. Geol. Surv. W. Australia, no. 103, pt. 2, pp. 108–130.

MURGOCI (G.), 1900. Über die Einschlüsse von Granatvesuvianfels in dem Serpentine des Paringu Massif. Bull. Sci. Bukarest, 9, pp. 568–612, 764–831.

WATSON (K. P.), 1942. Zoisite-prehnite alteration of gabbro. Amer. Min., vol. 27, pp. 638–645. [M.A. **9**–167.]

—— 1953. Prehnitization of albitite. Amer. Min., vol. 38, pp. 197-206. [M.A. **12**–273.]