MINERALOGICAL MAGAZINE, JUNE 1974, VOL. 39, PP. 721–2.

Ilmenites from Kakanui, New Zealand

THE Kakanui Mineral Breccia has been intensively investigated during the past ten years, following the upsurge of interest in possible upper mantle materials. Dickey (1965) mapped the formation and presented chemical and optical data on a wide range of minerals from xenocrysts and xenoliths within the breccia. Mason (1966, 1968) has also investigated some of the xenoliths and xenocrysts, while other recent investigations include those of White, Chappell, and Jakes (1972) and of Dasch, Evans, and Essene (1970). Both Mason and Dickey report the presence of ilmenite in the Mineral Breccia, Dickey reports ilmenite as a discrete nodule and as inclusions in the melanephelinite bombs, while Mason states that ilmenite is a common accessory in the eclogitic xenoliths. This paper presents data on the discrete ilmenite nodule and ilmenite inclusions in the melanephelinite, thought by Dickey to be the parental magma of the breccia.

Only one discrete nodule has been recorded from the breccia and Dickey (1965) describes the occurrence as follows: 'a xenolith . . . of interlocking ilmenite crystals with a minute amount of an unidentified interstitial substance. . . . This is a discoid nodule, approximately four centimetres in diameter, and two centimetres thick. Its surface appears to be pitted and fused. The individual crystals are xenomorphic and up to 0·5 centimetres across; some are twinned; none display exsolution textures. The interstitial substance, which occupies less than 2 % of the rock's volume, is an orange brown powder, presumably a ferruginous alteration product.' X-ray diffraction analysis has shown that the interstitial material is phillipsite, a mineral common in altered lherzolite inclusions and in the groundmass of the breccia. Ilmenite also occurs widely distributed in the inclusions of melanephelinite within the breccia. The fragments of ilmenite are small, rarely exceeding 1 cm in length, and have rounded, and sometimes embayed, outlines.

Examination in reflected light and with the electron microprobe have failed to show any exsolution features or variations in composition of the minerals as shown for kimberlitic ilmenites by Frisch (1970). A sample of the nodular ilmenite and an ilmenite from the melanephelinite have been analysed by electron microprobe and the results are presented in Table I, together with ferrous iron contents determined by conventional wet chemical methods. Results of a qualitative optical emission spectrographic analysis are also given. The analyses show that the two minerals are essentially identical. The magnesium content of both samples is low and comparable with the values obtained by Frisch and Wright (1971) for ilmenite occurring as xenocrysts in alkali basalts, and with ilmenites from pyrope-bearing breccias described by Allen and Deans (1965), and by Lovering and Widdowson (1968). The structural formula shows a considerable deficiency in the divalent ions compared with the theoretical

2·00, whilst the summation of titanium and the trivalent ions is in excess of 2·00. The total number of cations is close to the ideal 4·00, and thus suggests that some of the trivalent ions may be substituting for the divalent ions. This uneven distribution is relatively common in ilmenites derived from high-pressure environments.

TABLE I. *Chemical and X-ray data for ilmenite from Kakanui*

	1	2		1a		2a	
TiO_2	45·66	46·09	Ti	1·679		1·697	
Fe_2O_3	17·44	17·76	Fe^{3+}	0·641	2·377	0·653	2·403
Al_2O_3	1·06	0·96	Al	0·057		0·053	
Cr_2O_3	0·01	0·01	Cr	tr.		tr.	
FeO	31·72	32·19	Fe^{2+}	1·297		1·317	
MgO	3·95	3·09	Mg	0·288	1·594	0·226	1·552
MnO	0·23	0·26	Mn	0·009		0·009	
	100·07	100·36					

1. OU 20282, ilmenite xenocryst; *a* 5·079, *c* 13·960 Å, V 311·83 Å^3 (Mn-filtered Fe radiation, 114.83 mm diam. camera); qualitative spectrographic analysis gave Ti, Fe major, Al minor, Ba, Mn, V high trace, Cr, Na low trace.

2. OU 20289, ilmenite fragment in melanephelinite

1a, 2a. Cations on a basis of 6 oxygens.

The occurrence of magnesian ilmenites at Kakanui comparable with those thought to have crystallized at depths of 30 to 60 km (Frisch and Wright, 1971) is further evidence supporting a deep-seated origin for the Kakanui Mineral Breccia as advocated by Dickey (1968), Mason (1968), and White *et al.* (1972).

Dept. of Geology,
University of Otago,
Dunedin, New Zealand
A. REAY

New Zealand Geological Survey,
Lower Hutt, New Zealand
C. P. WOOD

REFERENCES

ALLEN (J. B.) and DEANS (T.), 1965. *Min. Mag.* **34**, 16.
DASCH (E. J.), EVANS (A. L.), and ESSENE (E.), 1970. *Abstr. Ann. Meet. Geol. Soc. Amer.* 532.
DICKEY (J. S.), 1965. *Unpub. M.Sc. thesis Univ. of Otago.*
—— 1968. *Amer. Min.* **53**, 1304.
FRISCH (T.), 1970. *Earth Planet. Sci. Lett.* **8**, 329.
—— and WRIGHT (J. B.), 1971. *Neues Jahrb. Min. Monatsh.* 289.
LOVERING (J. F.), and WIDDOWSON (J. R.), 1968. *Earth Planet Sci. Lett.* **4**, 310.
MASON (B.), 1966. *N.Z. Journ. Geol. Geophys.* **9**, 474–80.
—— 1968. *Contr. Min. Petr.* **19**, 316–27.
WHITE (A. J. R.), CHAPPELL (B. W.) and JAKES (P.), 1972. Ibid. **34**, 185.

[*Manuscript received 21 August 1973*]