Appendix B — Chemical

An examination of dolomites from Rumness by W. Pollard.

This report was prepared at the end of 1898.

Specimen No.	
(S8129) [NC 412 673]	Quarry, 150 yards east of Sango Bay. Mottled dolomite. Crystals of carbonate, mostly with irregular outlines, from 0.1 to 0.3mm. diameter. Occasional small veins of limonite (?) between the crystals. The mottling seems to be due to very minute black grains included in many of the crystals. The crystals which outline the dark patches in the rock appear to contain more of these black inclusions.
(S8130) [NC 43 67]	Eileen Roan. Crystals of carbonate, mostly with irregular outlines, from 0.08 to 0.2mm. diameter. Occasional grains and veins of limonite. Some very minute black grains as inclusions, less plentiful than in No. (S8129) [NC 412 673].
(S8131) [NC 441 671]	From the Eilean Dubh group, Eilean Roan. Compact carbonate rock. Crystals of dolomite, with irregular outlines, from 0.005 to 0.003mm. diameter, and occasional quartz grains of about the same size. Small veins and patches of limonite.
(S8132) [NC 361 631]	Dolomitic limestone in fucoid shales, near Ghrudaidh. Impure carbonate rock with limonite (1) rounded grains of quartz, and a pleochroic mineral, possibly hornblende. The crystals of carbonate vary considerably in diameter (from 0.6 to 0.05mm.). The rock is obviously of organic origin.
(S8133) [NC 387 663]	Big Croisaphuill. Bands of crystalline carbonate (crystals about 0.2mm. in diameter) with some limonite, and crypto-crystalline silica, containing crystals of carbonate (from 0.1 to 0.2mm. diameter). There are minute black grains, possibly carbon, included in the dolomite crystals. (From the analysis given later, it will be seen that the crystals in the bands of cryptocrystalline silica are almost entirely calcite.)
(S8283) [NC 432 671]	Eilean Dubh group, A'Ghoil Sgeir, near Eilean Roan. Compact carbonate rock. Crystals of carbonate, with more or less irregular outlines, occasional veins of limonite, and small carbonate crystals. Some short veins of micro-crystalline-quartz. In the slice there is one patch of carbonate crystals, larger than the main mass, with V-shaped markings of limonite, probably formed by decomposition of crystals of siderite.

* This report was prepared at the end of 1898.

The specific gravity of these rocks shows a very small variation comparatively, as is seen by the following list :-

Specimens which have been sliced.

Specimen No.		
(S8129) [NC 412 673]	Quarry, 150 yards east of Sango Bay, Durness	2.84
(S8130) [NC 43 67]	Eilean Hoan, 2.5 miles east of Durness	2.85
(S8131) [NC 441 671]	Eilean Hoan, Durness	2.82
(S8132) [NC 361 631]	Dolomitic limestone in fucoid shales, near Ghrudaidh, Kyle of Durness	2.81
(S8133) [NC 387 663]	Big Croisaphuill — Coarse part (dolomite)	2.78
(S8133) [NC 387 663]	Big Croisaphuill — Compact part (cakite and silica)	2.67
(S8283) [NC 432 671]	Eilean Dubh group, A'Ghoil Sgeir, near Eilean Hoan, Durness	2.85
	The specific gravity of the other specimens is as follows:	
Collector's No.		
(M2882)	Eilean Dubh, Durness	2.85
(M2883)	Eilean Dubh, group, Sailmhor	2.83
(M2884)	Eilean Dubh, base of mottled group, Sailmhor	2.85
(M2885)	Eilean Dubh	max. 2.86
(M2886)	Mottled limestone, Eilean Hoan	2.84
(M2887)	Dolomitic limestone, Eilean Hoan, 2.5 miles east of Durness	2.83
(M2888)	Middle of mottled group, east of Sailmhor	2.85
(M2890)	Flaggy beds, middle of Eilean Dubh group, near Sailmhor	2.82
(M2891)	Dolomite above chert, base of Sangomore group	2.81
(M2896)	Near top of mottled group, Sailmhor	2.84
(M2897)	Limestone Skerry, Baile na Cille Bay	2.82
(M2901)	Overlying chert bed, Sangomore	2.84
(M2903)	Overlying chert bed, Sangomore	2.84
(M2905)	Thin band of dolomite in Big Croisaphuill, east side of L. Borralaidh	2.84
(M2907)	About middle of mottled group, Sailmhor	2.84
(M2911)	Roadside, 250 yards east of Sangomore	2.83
(M2913)	Top of Eilean Dubh, Sailmhor,. . max.	2.86
(M2916)	Limestone Skerry, Baile na Cille Bay	2 85
(M2918)	Limestone Skerry, Baile na Cille Bay	2.80
(M2919)	Limestone Skerry, Baile na Cille Bay	2.85
(M2920)	Limestone Skerry, Baile na Cille Bay	2.84
(M2921)	Limestone Skerry, Baile na Cille Bay	Min 2.73
(M2922)	Limestone Skerry, Baile na Cille Bay	2.82
(M2923)	Limestone Skerry, Baile na Cille Bay	2.84
(M549d)	*Salterella* Series, Ghrudaidh group	2.85

The highest (2.86) are (M2885) and (M2913). The lowest (2.73) (M2921), as the compact part of Big Croisaphuill, cannot well be considered, consisting, as is seen from the analysis, of over 50 per cent. of silica. It seems that the above specimens are in all probability all dolomites (with perhaps one or two exceptions) of a greater or less degree of purity. A. chemical analysis was made of the six specimens which were sliced, the results of which are given below. Attention

should be drawn to No. (S8132) [NC 361 631]. The analysis given is from a sample taken from the hand specimen near to where it was sliced. Later on some of the residue was wanted for a microscopical examination, and a fresh chip was taken from the hand specimen. The amount of residue in this sample was over 5 per cent. lower than in the first one. It is probable that the amount of residue would vary considerably in different samples of the rock.

Nos. of specimens	(S8129) [NC 412 673]	(S8130) [NC 43 67]	(S8131) [NC 441 671]	(S8132) [NC 361 631]	(S8283) [NC 432 671]
Specific gravity	2.84	2.85	2.82	2.81	2.85
Part insol. dil. HCl	l.83	2.42	15 81	28.96	2.01
SiO_2	0.16	0.11	0.29	0.49	0.07
FeO	—	0.34	0.32	1.52	0.35
Fe_2O_3	0.21	0.28	0.36	0.29	0.10
Al_2O_3				0.50	
P_2O_5	trace (?)	trace	0.05	.62	trace
MnO	0.17	0.24	0.19	0.33	trace
CaO	29.65	30.05	25.40	21.73	30.09
MgO	21.53	20.25	18.24	13.61	20.83
CO_2	46.62	46.15	39.65	31.45	46.59
H_2O (at 105°C.)	—	—	—	0.09	0.28
H_2O (above 105°C.)	—	—	—	70	
	100.17	99.84	100.31	l00.29	100.32

Ratio of	CaO	:	MgO	:	CO_2
(S8129) [NC 412 673]	1	:	1.02	:	2.0
(S8130) [NC 43 67]	l.06	:	1	:	2.07
(S8131) [NC 441 671]	1	:	1	:	1.99
(S8132) [NC 361 631]	1.14	:	1	:	2.10
(S8283) [NC 432 671]	1.03	:	1	:	2.03

Note: A rough analysis of (M2921), specific gravity 2.73, gave Insoluble Residue 19.9 per cent., Fe_2O_3, Al_2O_3., 1.7, MgO 4.4, CaO 38.0-so this is a dolomitic limestone, not a dolomite. The specific gravity showed it was probably a limestone.

Specimen No.	
(S8129) [NC 412 673]	The residue insoluble in hot dilute hydrochloric acid was blackish. About 50 grams of the rock was dissolved in HCl., the residue boiled three or four times with fresh changes of HCl. finally washed by decantation and dried at 100°C. Under the microscope a fine black powder was observed, mixed with the silica, &c. On igniting the powder it became white, and ignited with copper oxide CO_2 was given off The loss on ignition of this residue was about 3.4 per cent., or, calculated on the original rock, 0.06 per cent. Hence the mottling is probably due to finely-divided carbon in the rock, and about 0.06 per cent.
(S8131) [NC 441 671]-(S8132) [NC 361 631]	The residue, insoluble in acid, consists mainly of silica, with some iron and alumina.
(S8133) [NC 387 663]	Big Croisaphuill. The compact part was separated from the crystalline part and the two analysed separately.

	Coarse Crystalline part	Compact part
Specific gravity	2.78	2.67
Part insol. HCl	1.73	56.01
SiO_2	0.13	0.22
FeO	0.16	{0.27
Fe_2O_3, Al_2O_3	0.13	
MnO	0.25	trace
CaO	32.54	22.43
MgO	19.06	1.40
CO_2	45.82	19.24
H_2O	—	0.31
	99.82	99.88

The ratio CaO : MgO : CO, in the crystalline part is 1.16 : 1 : 2.09, so there is probably a small amount of calcium carbonate with the dolomite.

The residue of the compact part consists almost entirely of silica (99.2 per cent.). Crypto-crystalline silica usually contains a considerable amount of water (2 per cent, or more), but in this case there is hardly any.

From the above analyses and specific gravity determinations, practically all these specimens are *dolomites.* Nos. 8132 and 8133 (crystalline part) contain rather more Ca003 than is required for dolomite.

A number of analyses of limestones from Sutherlandshire were made by Dr. Anderson [*Report of the Highland and Agricultural Society,* 1851–53, p. 273], twelve of which are more or less of interest in connection with this district. The localities are given below with percentage of $CaCO_3$ and $MgCO_3$.

		$CaCO_3$	$MgCO_3$
4	Knockdu Elpine, bluish grey	41.58	33.47
5	Knockdu Elpine, greenish grey with marble-like texture }	53.77	41.01
6	Durness	90.01	6.50
7	Eireboll, from seaside	51.04	41.36
8	Eireboll, powdered limestone	49.50	40.85
9	Achmore, pale blue-grey	53.51	43.20
10	*Achmore,* darker and more crystalline	54.88	41.85
11	Stronchrubie, white crystalline	45.79	48.72
12	Stronchrubie, dark grey	48.00	42.01
13	Kirktown	50.21	41.22
14	Ledbeg, nearly white crystalline	90.6	8.2
15	Ledbeg, grey and earthy	51.33	41.08

Dr. Anderson points out that the large amount of magnesium prevents these limestones from being of much use in agriculture.

Professor Heddle (*Min. Mag.,* iv., 239) quotes Dr. Anderson's analyses and gives three analyses of Durness limestone.

It may be of interest to give the following two analyses of specimens from Strath, Skye, which were made for Mr. Harker.

Specimen numbers	(S8063) [NG 624 217]	(S8064) [NG 622 196]
Specific gravity	2.85	2.86

Part insol. HCl	216		{1.72
SiO_2	0.50		
Fe_2O_3, Al_2O_3	0.45		0.34
MnO	12		0.19
CaO	30.50		30.53
MgO	21.19		20.81
CO_2	44.54		46.25
	99.66		99.84

Ratio of	CaO	MgO	CO_2
8063	1.03 :	1 :	1.91
8064	1.05	1 :	2.02

It is most probable that where there is more CaO than the amount required by the MgO to form dolomite the CaO is present (combined with 002) as calcite ; that is to say that the specimen is mainly dolomite, with a little calcite [as in (S8132) [NC 361 631] and the crystalline part of (S8133) [NC 387 663]]. The action of 1 per cent. HCl was tried on one of Mr. Harker's specimens for varying lengths of time (15 and 25 minutes about) and the ratio of CaO : MgO, which was dissolved, determined. Two parallel experiments with a mixture of calcite and magnesite (in the proportion of $CaCO_3$ $MgCO_3$) were also made. In the case of the dolomite the ratios were 1.03 CaO : 1 MgO and 1.06 : 1, whilst in the mixture 1.4 CaO : 1 Mg) and 1.6 CaO : 1 MgO. The ratio of CaO : Mg) dissolved by water saturated with CO_2 at ordinary temperatures was tried on the same sample and on a sample of (S8129) [NC 412 673] (M2895). A blind experiment with calcite and magnesite was made also.

In the case of the dolomites the ratio was CaO : MgO = 1.3 : 1 and 1.01: 1, whilst in the blind the ratio was CaO : Mg) = 5.9 : 1. It seems hence practically certain that we have true dolomites, and not mixtures of calcite and magnesite.

It would be interesting to examine the behaviour of dolomitic limestones, which contain more calcium and less magnesium than true dolomite, in dilute acids, as, although much has been done in that direction, the results vary greatly. [References given in Zirkel *Petrographie, vol.* iii., 1894, p. 495.] [Action of CO_2 Doelter & Hoernes *Jahrb d, K.K. Geol. Reichst.,* xxv., 300.]