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Short Note

Ferrar Dolerite Clasts from CRP-1 Drillcore

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INTRODUCTION

One of the objectives of the Cape Roberts Project is to study the tectonic history of the western Ross Sea region. Timing of the uplift of the Transantarctic Mountains, which are adjacent to the drillsite, will be a component of the tectonic studies (International Steering Committee, 1994; Cape Roberts Science Team, 1998a). The study of clast samples from the core will be an important means of providing insight into the timing of uplift of the Transantarctic Mountains.

Tholeiitic igneous rocks of the Jurassic (180 Ma) Ferrar large igneous province (FLIP) are widespread along the Transantarctic Mountains and have the potential to provide distinct indicators of erosion during uplift of the mountains. In the Transantarctic Mountains adjacent to the Cape Roberts drill site the FLIP is represented by lavas and pyroclastic rocks of the Kirkpatrick basalts and by thick Ferrar dolerite sills which intrude the Beacon Supergroup sediments and, occasionally, the granitic basement rocks. In the Prince Albert Mountains, the youngest Kirkpatrick basalt lava is over 150 m thick, and has a very distinct high TiO_2 chemical composition which is unique in the FLIP. If such rocks can be identified in the core they may provide precise timing of the initiation of uplift and denudation of the Transantarctic Mountains.

Here we report on an examination of 20 Ferrar dolerite clasts. This brief report is intended as a pilot study to the examination of FLIP clasts from older drillcore.

SAMPLES AND ANALYTICAL TECHNIQUES

Twenty three clast samples were collected from various intervals along the length of the core. Twenty of the samples were Ferrar dolerites (Tab. 1), whereas the other three clasts consisted of a metasediment (61.57 metres below sea floor (mbsf)), a sandstone clast (114.76 mbsf) and a porphyritic intermediate McMurdo Volcanic Group lava (144.17 mbsf). All Ferrar dolerite samples were examined in thin section. Nine of the larger dolerite clasts were analyzed by XRF for major and trace element compositions (Tab. 2) using standard techniques (see Krissek & Kyle, this volume). Two dolerites (32.82 and 123.19 mbsf) were briefly examined by electron microprobe to confirm mineralogical identifications.

DISCUSSION

Clasts of Ferrar dolerite have been identified throughout the CRP-1 drillcore and, together with granite, are the most abundant clast types (Cape Roberts Science Team, 1998b; Cape Roberts Science Team, 1998c). Extensive areas of Ferrar dolerite occur to the north of the Mackay Glacier, and their high abundance in the core is consistent with the local geology.

Tab. 1 - Ferrar Dolerite clasts in drillcore from CRP-1.

Depth mbsf	Volume cm^3	Description
21.84	20	c.g. dolerite, strong deuteric alteration, granophyric groundmass
32.82	60	altered c.g. dolerite, chlorite and biotite replace pyroxene
39.00	3	f.g. equigranular dolerite, abundant cryptocrystalline groundmass
41.37	6	c.g. dolerite, deuteric alteration, granophyric mesostasis
55.00	60	strongly deuteric altered m.g. dolerite, chloritized
63.12	40	strongly deuteric altered m.g. dolerite
72.97	25	altered c.g. dolerite, chlorite and biotite replace pyroxene
92.20	6	f.g. dolerite, sub-ophitic texture, strong deuteric alteration
96.72	20	c.g. dolerite, deuteric alteration
104.49	12	altered m.g. dolerite, chlorite and biotite replace pyroxene
106.15	4	c.g. dolerite, deuteric altered and cryptocrystalline mesostasis
108.41	60	c.g. dolerite, sub-ophitic texture, deuteric altered pyroxene
123.19	60	c.g dolerite, deuteric alteration of pyroxene, secondary chlorite
125.95	6	c.g. dolerite, sub-ophitic texture, deuteric altered pyroxene
127.48	20	strongly deuteric altered f.g. dolerite
131.28	35	f.g. equigranular dolerite, pyroxene replaced by chlorite and biotite
132.62	20	altered c.g. dolerite, chlorite and biotite replace pyroxene
133.09	4	c.g dolerite, deuteric alteration of pyroxene, secondary chlorite
134.63	45	c.g dolerite, deuteric alteration of pyroxene
137.16	50	c.g. dolerite, deuteric altered and cryptocrystalline mesostasis

Note: c.g.- coarse grained (>1 mm), m.g.- medium grained (0.5 to 1 mm), f.g.- fine grained (<0.5 mm).

Tab. 2 - Analyses of Ferrar Dolerite clasts from CRP-1.

Depth mbsf	32.82	55.00	63.12	72.97	108.41	123.19	131.28	134.63	137.16
SiO_2	54.00	60.57	56.34	54.66	54.70	54.57	54.67	53.38	54.36
TiO_2	1.22	1.45	0.92	0.60	0.78	0.75	1.08	0.67	0.79
Al_2O_3	17.19	11.65	13.95	14.71	14.17	16.23	17.54	16.11	14.26
Fe_2O_3	8.50	13.56	11.00	10.02	10.58	10.42	8.52	10.11	10.47
MnO	0.123	0.165	0.167	0.163	0.163	0.155	0.136	0.157	0.159
MgO	3.53	1.14	4.31	6.26	5.40	3.92	3.04	4.53	4.41
CaO	7.32	4.83	8.69	10.18	9.64	9.72	5.83	10.18	8.92
Na_2O	3.14	2.89	2.31	1.95	2.15	2.54	3.78	2.20	2.34
K_2O	2.46	2.28	1.29	0.88	1.09	1.07	3.10	0.99	1.15
P_2O_5	0.33	0.24	0.15	0.10	0.11	0.10	0.36	0.09	0.13
L.O.I.	0.81	1.08	0.98	0.53	0.57	0.67	0.80	0.59	0.93
SUM	98.62	99.86	100.10	100.06	99.36	100.15	98.85	99.01	97.92
V	153	153	280	269	284	242	132	254	279
Cr	28		50	114	76	15	8	20	23
Ni	11	6	50	79	71	36	8	49	51
Cu	20	86	108	74	123	142	8	125	156
Zn	95	130	93	79	83	80	103	79	86
Ga	22	19	17	15	17	18	21	17	17
Rb	74	91	47	32	39	41	126	37	37
Sr	688	106	133	138	131	147	576	137	145
Y	34	58	34	23	27	26	34	24	27
Zr	144	267	156	95	116	109	211	95	133
Nb	10	9	5		3		11		3
Ba	1144	510	340	236	280	271	688	247	308
Pb	13	16	11	7	9	9	12	9	9
Th	9	12	7	6	7	7	10	6	7
U		4	3		3	2	2		2

Petrographically, the dolerite samples are similar to those described in the Dry Valley area. Textures typically range from ophitic to doleritic, with sub-ophitic textures predominant. The grain size is mainly 0.5 to 4 mm but finer grained varieties also occur (Tab. 1). All samples show deuteric alteration which mainly affects the pyroxenes. Sericitic alteration of the plagioclase is common. Several samples (*e.g.* 32.82, 131.28, 132.62 mbsf) show strong hydrothermal alteration and the pyroxenes are replaced by biotite, hornblende and chlorite. The main mineral phases are plagioclase, augite, pigeonite and opaque oxides with mesostasis of quartz and feldspar. The pigeonite was rarely observed to be inverted to orthopyroxene.

Overall, the nine analysed samples (Tab. 2) are geochemically typical of Ferrar dolerites from the Transantarctic Mountains (Hamilton, 1965; Gunn, 1966; Hergt et al., 1989; Morrison & Reay, 1995). Geochemically the rocks would be classified as basaltic andesite using the TAS classification (LeBas et al., 1986). Sample 55.00 mbsf has higher SiO_2 and lower MgO, and is typical of granophyric material from the upper zone of a thick sill. The two analysed samples (32.82, 131.28 mbsf), which show alteration of the pyroxenes to biotite, hornblende and chlorite, are enriched in K_2O and Rb (Tab. 2) and have been subjected to potassic alteration. Although secondary biotite has been previously noted in Ferrar dolerites, the extent of the alteration of the two samples recorded here is significant. It is possible that these Ferrar clasts are derived from a larger intrusive body which had a hydrothermal system associated with it. The occurrence of hydrothermally altered Ferrar clasts in both the Quaternary and Miocene sections of the core suggest that the volume of these rocks has to be significant. No field occurrence of such altered Ferrar dolerites and evidence of significant hydro-thermal alteration has been previously noted in the Ferrar dolerite. Craw & Findlay (1984) have described hydrothermally altered Lower Ordovician granitoids and Devonian Beacon Sandstone from Taylor Valley. They considered convective hydrothermal circulation generated by a Ferrar dolerite intrusion to be the cause of the alteration. So it is apparent that hydrothermal systems were formed during the intrusion of the dolerites, and it likely that the dolerites themselves were subject to alteration.

No clasts of the Jurassic Kirkpatrick basalt were identified in the core, even though these rocks occur in the upper reaches of the Mackay Glacier, a potential source area for sediment and detritus to the Cape Roberts drillsite. Pebbles of possible Kirkpatrick basalt were recognised during $^{40}Ar/^{39}Ar$ dating by their Jurassic age (W. McIntosh, personal communication). The lack of significant Kirkpatrick basalt clasts suggests that by Miocene time erosion had reached deeper stratigraphic levels than the Kirkpatrick basalts. This would indicate some stability in the Transantarctic Mountains, and little or no significant uplift and down-cutting since the Miocene, unless the ice was confined to an existing-drainage system.

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