SHORT NOTES

RECENT OBSERVATIONS ON THE VOLCANIC HISTORY OF DECEPTION ISLAND, SOUTH SHETLAND ISLANDS

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INTRODUCTION

Deception Island is a young (< 750 ka) basaltic shield volcano with a large flooded caldera, situated astride a Quaternary (< 1.5 Ma) marginal basin spreading centre in Bransfield Strait, northern Antarctic Peninsula. The volcano was particularly active during the 19th century, with eruptions occurring during most decades (Orheim, 1972), but 20th-century eruptions have been confined to 1906–12 and 1967–70. The 'steaming hot cinder cone' near Whalers Bay reported by Birkenmajer (1987) is a fumarolic mound (first described by Baker and others, 1975) and does not represent new pyroclastic activity. Despite several volcanic studies (e.g. González-Ferrán and Katsui, 1970; Baker and others, 1975; Shultz, 1976; Weaver and others, 1979), the volcanic history of the island is known only in outline. Fieldwork undertaken by the British Antarctic Survey during two seasons between 1987 and 1988 is intended to address problems of the eruptive history and eruptive potential of the volcano, and the petrogenesis of magmas at a very young marginal basin spreading centre. The preliminary results of the fieldwork are presented here.

VOLCANIC HISTORY

As a result of the fieldwork, a new map of the solid geology has been prepared (Fig. 1), together with a new interpretation of the stratigraphy (Fig. 2). In accord with previous workers (e.g. Hawkes, 1961; González-Ferrán and Katsui, 1970; Baker and others, 1975), a distinct two-fold, evolution is indicated and linked to pre- and post-caldera events. The poorly known pre-caldera volcanism was probably polygenetic and accounts for 85% of the volcano. Most is beneath the sea, but basal exposures on the island consist of pillow lava and hyaloclastite, passing up into bright yellow hydroclastic lapilli-tuffs. A remnant of a pre-caldera lava shield is exposed in northern Stonethrow Ridge, consisting of massive and pahoehoe flows capped by pre- and post-caldera Strombolian deposits (Fig. 2) The youngest pre-caldera deposits consist of yellow, poorly bedded, poorly sorted fine lapilli-tuffs. They form a thick (> 70 m) multistorey unit, rich in accessory clasts and locally columnar jointed. For the most part the unit corresponds to the Outer Coast Tuff of Hawkes (1961). Its lithological characteristics indicate rapid accumulation by mass flow and it is interpreted as a deposit of multiple pyroclastic or hydroclastic flows. The structural position suggests a close, possibly genetic relationship with the caldera collapse event.

The products of post-caldera volcanism are divisible into at least three major rock groups. Magmatic eruptions from fissures mainly along the caldera rim resulted in red and black, welded and non-welded Strombolian fall deposits and clastogenic lavas. There is evidence for a variety of ages ranging from early post-caldera (as at Entrance Point) to recent times (1969 eruption). Eruptions within the caldera were almost

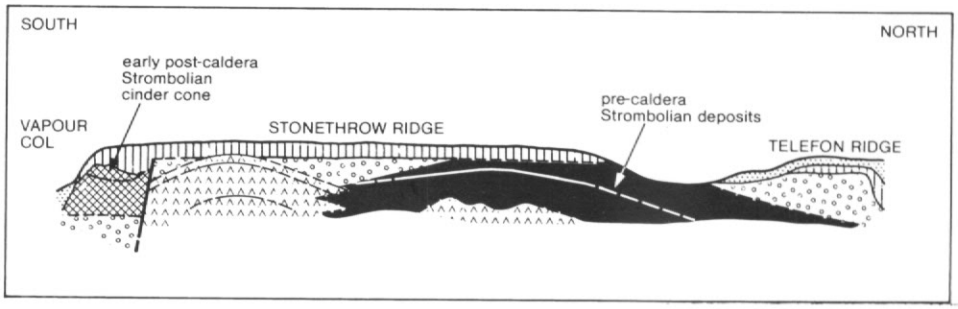

Fig. 2. Schematic vertical section through Stonethrow Ridge and southern Telefon Ridge, illustrating relationships between pre- and post-caldera deposits. Not to scale. See Fig. 1 for legend.

exclusively phreatomagmatic, forming numerous tuff cones and maars. Early post-caldera tuff cones are degraded and preserve no remnants of primary cone morphology. They are aligned along major north-east-trending normal faults, indicating a predominant structural control by regional extensional tectonics associated with marginal basin formation in Bransfield Strait. By contrast, the well-formed late post-caldera vents (maars and tuff cones) are aligned along concentric annular faults within the caldera indicating predominant volcano-tectonic control. This is an uncommon feature of post-caldera volcanism worldwide (Walker, 1984). In all the post-caldera tuff cones, early cone-building activity commonly produced poorly stratified, coarse tephra with characteristics of both magmatic and phreatomagmatic deposits. Later cone-building activity consisted mainly of ash-rich surge beds with abundant accessory lithic clasts and armoured lapilli. Planar, dune and antidune sandwave bedforms are characteristic. Multiple, superimposed channels are spectacularly exposed in the inner crater walls of a large crater in southern Vapour Col. They resemble erosional structures carved initially by streams followed by widening and deposition by multiple pyroclastic surges (cf. Fisher, 1977). Minor deposits preserved ephemerally in the small ring plains surrounding cones include massive, unsorted, matrix-supported beds, often with reverse-graded, erosive bases and vesiculated tops. They are interbedded with stratified surge beds and thin (?)airfall tuffs and most closely resemble pyroclastic or hydroclastic mass flow deposits.

Discussion

The volcanic history of Deception Island is dominated by pyroclastic rocks. The deposits were formed mainly during hydroclastic eruptions, but Strombolian scoria and clastogenic lavas were also erupted frequently from fissures around the caldera rim. The tuff cones and maars are constructed mainly from pyroclastic surge deposits, whereas airfall tephra, surge and mass flow deposits accumulated on the ring plains. Maars and ring plain deposits have a very low preservation potential due to intense fluvial reworking during periods of seasonally enhanced meltwater activity.

The structural history of the volcano is dominated by a major caldera collapse, which was preceded by the formation of voluminous mass flow deposits. New observations indicate that regional extension and local volcano-tectonic structures were both important in controlling vent locations during post-caldera times.

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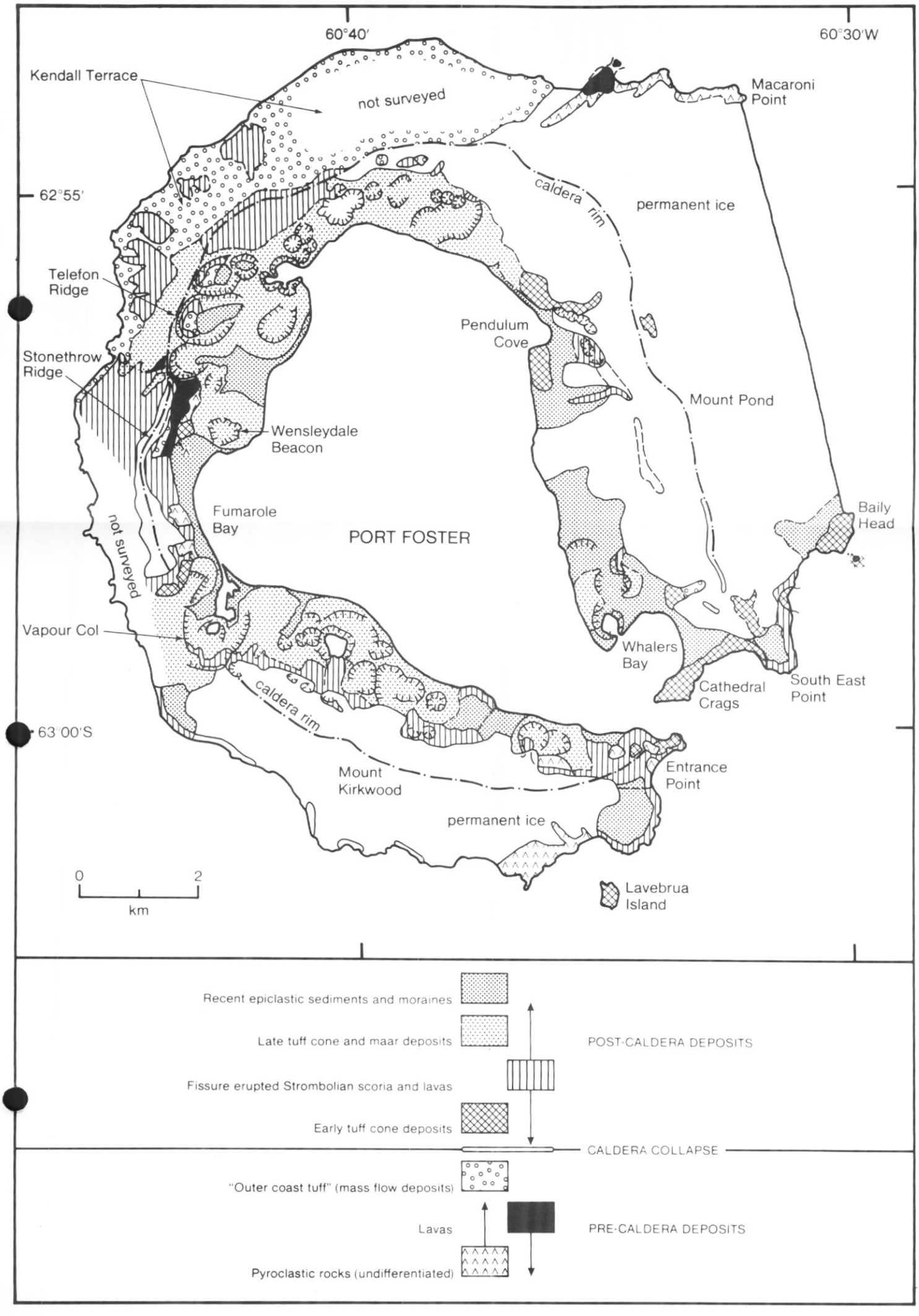

Fig. 1. Sketch map of Deception Island showing the simplified solid geology. Small cinder and tuff cones are omitted, for clarity.

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SEABIRD RECORDS FROM THE BELLINGSHAUSEN, AMUNDSEN AND ROSS SEAS

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INTRODUCTION

The seas between the Antarctic Peninsula and the Ross Ice Shelf are some of the least visited in the world. Consequently there are few data on the numbers and distribution of seabirds in these areas. It therefore seems worthwhile putting the results of a single long transect on record.

Observations were made between Anvers Island (Antarctic Peninsula) and Campbell Island (New Zealand) during a voyage of the MS *World Discoverer* from Punta Arenas (Chile) on 20 January to Port Bluff (New Zealand) on 21 February 1987. The route and places mentioned in the text are shown in Fig. 1.

All observations were made by us from the wing of the bridge (eye level *c.* 12 m above sea level) covering an arc of *c.* 180° looking forward to include the ship's bow. The speed of the ship during the voyage varied between 8 and 13 kts.

Observations were carried out for 3.0 to 8.2 h each day between 0830 and 1800 h (local time). Throughout the crossings weather and sea conditions were unexpectedly good but detailed observations were not kept when identification or counting was difficult. Only birds detected with the naked eye were counted but identification was confirmed using binoculars. Birds following in the wake were excluded from counts and, whenever possible, birds repeatedly circling the ship were counted only once. We did not attempt to identify prions *Pachyptila* spp. or diving petrels *Pelecanoides* spp. to species. Counts of the main species seen are presented in Tables I and II and points

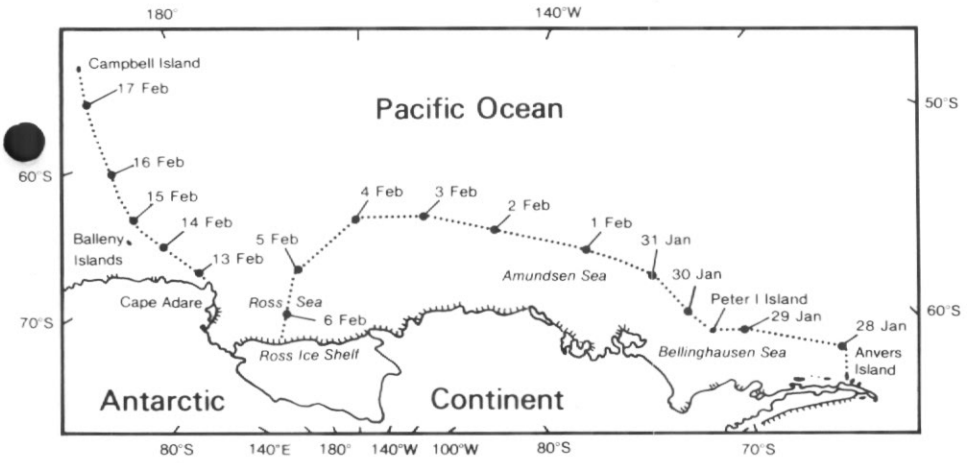

Fig. 1. Course followed by MS *World Discoverer* from Anvers Island to the Ross Ice Shelf and from Cape Adare to Campbell Island, January–February 1987. Other locations mentioned in the text and the ship's position at noon are also indicated.

of interest are mentioned below. Daily totals of whale sightings are also given in Tables I and II, whales which could be identified to species are listed in an appendix.

Observations

Anvers Island to Ross Ice Shelf

Observations were started on 28 January at 65° 37′ S, 71° 18′ W. Over the following nine days we travelled approximately 3200 nm (5900 km) westwards across the Bellingshausen, Amundsen and Ross seas and reached the Ross Ice Shelf at 76° 46′ S, 173° 29′ E on 6 February 1987. During the crossing the ship was mostly 10 to 100 nm (18 to 188 km) from the pack ice and 200 to 500 nm (370 to 1000 km) from the Antarctic continent.

A total of 7127 individuals of 17 species was counted. However, there were marked changes with latitude and longitude and no species was recorded on all ten days of the crossing (Table I). Numbers of both individuals and species were generally high near the Antarctic Peninsula and Ross Ice Shelf but the largest concentrations of birds were seen during the afternoon of 4 February between 68° 01′S, 164° 20′ W and 68° 16′ S, 165° 17′ W. In this area swarms of plankton were clearly visible in the sea and large flocks (up to 2100 individuals) of Antarctic petrels *Thalassoica antarctica* and blue petrels *Halobaena caerulea* were associated with these swarms. About 30 whales including 20 humpback whales *Megaptera novaeangliae* and two minke whales *Balaenoptera acutorostrata* were also seen. A similar association between Antarctic petrels and whales, in this case mainly minke whales, was observed at 74° 34′ S, 179° 22′ W on 6 February. In contrast only a single Wilson's storm petrel *Oceanites oceanicus* was recorded (in perfect viewing conditions) with a group of at least 30 pilot whales *Globicephala melaena*, one minke and one killer whale *Orcinus orca* at 67° 40′ S, 120° 35′ W on 1 February.

As we travelled west, Antarctic fulmars *Fulmarus glacialoides*, Cape pigeons *Daption capense* and Wilson's storm petrels were, to a large extent, replaced by blue petrels, Antarctic petrels and prions. It was noticeable that most of the blue and Antarctic petrels recorded between 67° 10′ S, 147° 36′ W and 66° 44′ S, 152° 41′ W were in wing moult. Peak numbers of Antarctic fulmars were seen in the vicinity of the large breeding colony on Peter I Island. The first snow petrel *Pagodroma nivea* was sighted about 10 nm (18 km) from the edge of the pack ice and we later saw at least 20 gliding along the edge of the Ross Ice Shelf.

The first Adélie penguins *Pygoscelis adeliae* were recorded standing on small ice floes at 70° 52′ S, 72° 02′ W (about 400 nm (740 km) from the Ross Ice Shelf) and a single emperor penguin *Aptenodytes forsteri* accompanied by about ten Adélies was seen on a floe at the base of the ice shelf. Other scarce species seen included a single black-bellied storm petrel *Fregetta grallaria* at 67° 37′ S, 84° 47′ W on 29 January, slightly south of its normal range (Harrison 1983), Kerguelen petrels *Pterodroma brevirostris* on 2 February (1) and 4 February (3) and five Arctic terns *Sterna paradisaea* (three in heavy moult) at 70° 34′ S, 178° 22′ W on 5 February.

Cape Adare to Campbell Island

Observations were started on 13 February at 70° 40′ S, 169° 20′ E. During the next four days we travelled approximately 1250 nm (2300 km) northwards from Cape Adare past the Balleny Islands to reach Campbell Island on the evening of 17 February.

Table I. Numbers and species of seabirds seen daily during a voyage from Anvers Island to the Ross Ice Shelf. Figures for seabirds in brackets indicate birds seen outside the observation period. The number of whales seen each day is also shown and the number of discrete groups is given in brackets

Date	28 Jan	29 Jan	30 Jan	31 Jan	1 Feb	2 Feb	3 Feb	4 Feb	5 Feb	6 Feb	
Position at noon	65° 48′ S 72° 49′ W	69°38′ S 84° 51′ W	68° 18′ S 94° 22′ W	67° 55′ S 108° 51′ W	67° 38′ S 122° 32′ W	67° 15′ S 136° 32′ W	66° 53′ S 149° 00′ W	67° 34′ S 161° 52′ W	71° 07′ S 172° 33′ W	75° 33′ S 176° 50′ E	
Distance from Antarctic Continent (km)	*c.* 700	*c.* 400	*c.* 370	*c.* 650	555	777	1017	962	650	370	
Distance from pack ice (km)	*c.* 100	*c.* 50	166	166	185	37	18	18	46	37	Total
Observations (hours)	3.0	4.7	4.7	4.2	4.7	4.5	4.3	8.2	7.5	5.7	51.5
Emperor penguin *Aptenodytes forsteri*	—	—	—	—	—	—	—	—	—	(1)	
Adélie penguin *Pygoscelis adeliae*	—	—	—	—	—	—	—	—	71	(300)	71
Black-browed albatross *Diomedea melanophris*	—	—	1	—	—	—	—	—	—	—	1
Light-mantled sooty albatross *Phoebetria palpebrata*	—	—	2	—	—	—	—	1	—	—	3
Southern giant petrel *Macronectes giganteus*	2	2	11	—	—	2	1	8	1	2 (1)	29
Antarctic fulmar *Fulmarus glacialoides*	14	445	33	8	—	3	46	1	1	—	561
Antarctic petrel *Thalassoica antarctica*	31	16	—	13	—	—	—	2250	80	862	3252
Cape pigeon *Daption capense*	41	61	300	144	28	5	—	2	1	—	582
Snow petrel *Pagodroma nivea*	—	—	—	—	—	—	3	3	8	39 (20)	53
Mottled petrel *Pterodroma inexpectata*	—	—	—	—	—	—	—	9	10	1	20
Kerguelen petrel *P. brevirostris*	—	—	—	—	—	1	—	3	—	—	4
Blue petrel *Halobaena caerulea*	1	4	5	—	11	53	11	2320	—	—	2405
Prions *Pachyptila* spp.	—	—	14	1	2	61	—	4	—	—	82
Wilson's storm petrel *Oceanites oceanicus*	19	8	14	1	—	—	—	3	5	7	57
Black-bellied storm petrel *Fregretta grallaria*	—	1	—	—	—	—	—	—	—	—	—
South polar skua *Catharacta maccormicki*	—	1	—	—	—	—	—	—	—	(3)	1
Arctic tern *Sterna paradisaea*	—	—	—	—	—	—	—	—	5	—	5
Whale spp.	2 (2)	8 (2)	6 (6)	0	34 (2)	0	0	31 (8)	12 (5)	40 (9)	133

Table II. Numbers and species of seabirds seen daily during a voyage from Cape Adare north to the Antarctic Convergence. Figures for seabirds in brackets indicate birds seen outside the observation periods. The number of whales seen each day is also shown, the number of discrete groups is given in brackets

Date	13 Feb	14 Feb	15 Feb	16 Feb	17 Feb	
Position at noon	70° 34′ S 169° 03′ E	67° 10′ S 164° 35′ E	63° 33′ S 164° 54′ E	59 18′ S 166° 45′ E	54° 31′ S 166° 45′ E	Total
Observations (hours)	4.8	3.5	5.5	6.5	4.7	25.0
Adélie penguin *Pygoscelis adeliae*	42	—	—	—	—	42
Rockhopper penguin *Eudyptes chrysocome*	—	—	—	—	3	3
Wandering albatross *Diomedea exulans*	—	—	—	—	4	4
Royal albatross *D. epomophora*	—	—	—	4	1	5
Black-browed albatross *D. melanophris*	(1)	10	7	16	47	80
White-capped albatross *D. cauta*	—	—	—	1	5	6
Grey-headed albatross *D. chrysostoma*	—	—	2	6	10	18
Light-mantled sooty albatross *Phoebetria palpebrata*	4	5	1	2	18	30
Northern giant petrel *Macronectes halli*	—	—	1	} 1	2	4
Southern giant petrel *Macronectes giganteus*	5	1	—		—	6
Antarctic fulmar *Fulmarus glacialoides*	3	196	—	—	—	199
Antarctic petrel *Thalassoica antarctica*	13	6	—	—	—	19
Cape pigeon *Daption capense*	2	112	—	18	16	148
Snow petrel *Pagodroma nivea*	259	3	—	—	—	262
Great-winged petrel *Pterodroma macroptera*	—	2	—	3	4	9
White-headed petrel *P. lessonii*	—	6	5	12	20	43
Mottled petrel *P. inexpectata*	17	49	—	6	4	76
Prions *Pachyptila* spp.	1	33	42	17	16	109
Grey petrel *Procellaria cinerea*	—	—	—	—	1	1
White-chinned petrel *P. aequinoctialis*	—	—	—	—	13	13
Sooty shearwater *Puffinus griseus*	—	202	362	113	342	1019
Little shearwater *P. assimilis*	—	—	—	—	4	4
Wilson's storm petrel *Oceanites oceanicus*	21	5	—	—	—	25
White-faced storm petrel *Pelagodroma marina*	—	—	—	—	1	1
Black-bellied storm petrel *Fregetta tropica*	—	—	—	—	24	24
Diving petrel *Pelecanoides* spp.	—	—	19	6	2	27
South polar skua *Catharacta maccormicki*	1	—	—	—	—	1
Arctic tern *Sterna paradisaea*	8	—	—	—	—	8
Whale spp.	3 (2)*	0*	4 (2)	2 (1)	5 (2)	14

* Weather conditions on 13–14 February were poor and whales could easily have been overlooked.

A total of 2186 individuals of at least 28 species (prions and diving petrels not identified to species) was seen (Table II). Juvenile Adélie penguins and snow petrels were abundant in pack ice at 69° 51′ S, 170° 18′ E, approximately 80 nm (150 km) from Cape Adare. These two species along with southern giant petrels *Macronectes giganteus*, Antarctic fulmar, Antarctic petrel, Wilson's storm petrel, south polar skua *Catharacta maccormicki* and Arctic tern were not seen north of 63° S. North of the Antarctic Convergence (*c.* 60° S) there was a marked increase in the number of species and black-browed albatross *Diomedea melanophris*, grey-headed albatross *D. chrysostoma*, light-mantled sooty albatross *Phoebetria palpebrata* and white-headed petrels *Pterodroma lessonii* became abundant with the occasional royal albatross *Diomedea epomophora*, white-capped albatross *D. cauta* and great-winged petrel *Pterodroma macroptera*. Northern giant petrels *Macronectes halli*, replaced their southern cogeners Cape pigeons and mottled petrels *Pterodroma inexpectata* had a bimodal distribution being absent between *c.* 65 to 61° S on 15 February. The first sooty shearwater *Puffinus griseus* was seen at 67° S, 164° E just north of Sturge Island in the Balleny group, and this was the most numerous species for the remainder of the voyage to Campbell Island. The species diversity continued to increase as we approached Campbell Island and seven species were seen only within 170 nm (310 km) of the island.

Our records of species' distributions were similar to those obtained by more systematic surveys, e.g. Darby (1970), Hicks (1973), Zink (1981) and Ainley and others (1984). Although they provide little new information on any of the species, the transects did cross areas which are still relatively poorly surveyed. Only by regular recording and writing up of results by those lucky enough to visit these areas will the distribution of southern seabirds and the factors which control their distribution become known.

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Appendix 1. Locations and group sizes of whales which could be identified to species during voyages from Anvers Island to the Ross Ice Shelf and from Cape Adare to Campbell Island, January–February 1987.

Date	*Position*	*Species*	
29 Jan	67° 15′ S, 83° 00′ W	Minke whale	(3) *Balaenoptera acutorostrata*
	67° 15′ S, 83° 15′ W		(5) *Balaenoptera acutorostrata*
30 Jan	68° 18′ S, 94° 06′ W		(1)
	68° 18′ S, 94° 11′ W	Minke whale	(1)
	68° 14′ S, 95° 34′ W		(1)
1 Feb	67° 40′ S, 120° 35′ W	Pilot whale	(*c.* 30) *Globicephala melaena*
	67° 40′ S, 120° 35′ W	Minke whale	(1)
	67° 40′ S, 120° 35′ W	Killer whale	(1) *Orcinus orca*
4 Feb	67° 37′ S, 162° 00′ W	Minke whale	(1)
	67° 37′ S, 163° 10′ W		(7) *Megaptera novaeangliae*
	68° 00′ S, 163° 10′ W	Humpback whale	(1) *Megaptera novaeangliae*
	68° 00′ S, 164° 08′ W		(1) *Megaptera novaeangliae*
	68° 00′ S, 164° 08′ W		(3) *Megaptera novaeangliae*
	68° 01′ S, 164° 20′ W		(3) *Megaptera novaeangliae*
	68° 01′ S, 164° 20′ W	Minke whale	(2)
5 Feb	71° 16′ S, 172° 51′ W		(2)
	71° 16′ S, 172° 55′ W	Minke whale	(4)
	71° 44′ S, 173° 45′ W		(4)
	72° 16′ S, 175° 05′ W		(1)
6 Feb	74° 34′ S, 179° 22′ W		(*c.* 30 in 4 groups)
	74° 34′ S, 179° 30′ W	Minke whale	(5)
	74° 34′ S, 179° 32′ W		(2)
	76° 46′ S, 173° 29′ W	Fin whale	(1) *Balaenoptera physalus*
	76° 46′ S, 173° 29′ W	Minke whale	(1)
13 Feb	69° 55′ S, 169° 11′ E	Minke whale	(1)
	69° 50′ S, 169° 11′ E		(1)
15 Feb	64° 00′ S, 164° 46′ E	Minke whale	(3)
16 Feb	59° 24′ S, 166° 46′ E	Killer whale	(2)
17 Feb	53° 45′ S, 167° 47′ E	Long-snouted spinner dolphin (1) *Stenella longirostris*	