SHORT NOTES

IRON, MANGANESE AND SILICON IN WATERS OF DECEPTION ISLAND

By H. ELDERFIELD*

ABSTRACT. Water samples from crater lakes on Deception Island and from coastal sea-waters collected immediately prior to the 1969 eruption are often enriched in Fe, Mn and Si, indicating a significant volcanic source for these elements.

THERE is considerable speculation in the literature as to the role of volcanism in the formation of certain types of sedimentary deposit. In many discussions of the origin of ferromanganese nodules, for example, the close association has been stressed of nodules and altered volcanic products (e.g. Arrhenius and others, 1964; Bonatti and Nayudu, 1965), and the coincidence of Fe- and Mn-rich sediments with areas of high heat-flow (Bostrom and Peterson, 1966) has been regarded as evidence of a volcanic supply of metals to marine sediments. Also, the formation of porcellanites and cherts by the alteration of volcanic debris has been repeatedly stressed (e.g. White and others, 1964; Calvert, 1971). However, the majority of the data in the literature reveals only a physical relationship between metal enrichments and volcanism, which does not necessarily argue for a genetic association between these parameters. The most revealing information is to be gained from direct observations of volcanic phenomena and their effect on water and sediment chemistry, but this is rarely possible because of the unpredictable nature of these phenomena. During the period December 1968–January 1969, a series of water samples was collected from on and around Deception Island, prior to the eruption of February 1969, and gave an opportunity to study the effect of volcanism on the composition of natural waters.

Water samples were collected from crater lakes and coastal sea-water, and were analysed for pH, salinity, Na, K, Ca, Mg, Sr, Cl, SO_4, HCO_3, F, Fe, Mn, Si, Al, Cu, Pb, Co, Ni and Zn. The detailed results have been considered elsewhere (Elderfield, 1972); this note summarizes the analytical data for Fe, Mn and Si (Table I). These elements showed considerable variation

TABLE I. Fe, Mn AND Si IN DECEPTION ISLAND WATERS

Water type	*Sample number*	*Date collected*	Fe	Mn (μg./l.)	Si
Sea-water	D1	23 December 1968	n.d.	130	4,400
	D2	13 January 1969	n.d.	70	5,890
	D3	24 January 1969	180	60	7,160
	D4	27 January 1969	n.d.	30	7,770
Crater open to sea	D5	27 January 1969	n.d.	560	7,430
Crater lakes	D6	11 December 1968	n.d.	1,550	29,600
	D7	4 December 1968	310	2,420	36,500
	D8	19 January 1969	n.d.	1,810	50,700
Average sea-water			10	2	3,000

n.d. Not detected.

Precise sample locations and analytical details have been given by Elderfield (1972). Fe concentrations represent amount passing through 0·45 μm. filter.

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from their levels in average sea-water. Si concentrations in the coastal sea-waters increased from background levels on 23 December 1968 to approximately 2·5 times this level on 27 January 1969, and waters from enclosed crater lakes were considerably enriched in Si (up to 50,700 μg./l.). Mn was also high in coastal sea-waters but, in contrast to Si, decreased temporally from 130 to 30 μg./l.; up to 2,420 μg. Mn/l. was found in crater-lake waters. Since Fe is readily hydrolysed in oxygenated waters, any locally supplied iron is likely to be added rapidly to the sediment. Nevertheless, two samples contained high levels of this element, probably due to sub- 0·45 μm. particulates.

While Fe, Mn and Si were considerably enriched in certain samples, other elements were present at normal levels (Elderfield, 1972), indicating a volcanic supply of these three metals to Deception Island waters. Further work is necessary before the supply mechanism can be determined.

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OBSERVATIONS ON A SMALL CRABEATER SEAL BREEDING GROUP

By R. W. M. CORNER

ABSTRACT. A breeding group of crabeater seals comprising a female with her pup and an adult male was observed over a period of 12 days at the Argentine Islands, Antarctic Peninsula. Other new records of similar groups are presented and their significance discussed.

SIGHTINGS of crabeater seal (*Lobodon carcinophagus*) pups are infrequently made, because parturition usually occurs in the pack-ice zone in spring when observers are absent from this area. King (1957) described a crabeater pup from Port Lockroy which was accompanied by its mother and an adult male, and Øritsland (1970) gave an account of observations made in August–October during a sealing expedition. He saw 19 non-pregnant adult females paired with adult males, and each of three females which had given birth were in company with mature males. In October 1964, the opportunity was taken to observe such a group over a period of 12 days at the Argentine Islands, Antarctic Peninsula (lat. 65°15′S., long. 64°16′W.).

OBSERVATIONS

On the evening of 18 October, a male and female crabeater seal and a female pup were seen on the fast ice at the north-east tip of Galindez Island. Tracks were seen leading from an open pool at the entrance to Meek Channel, the only open water in the island group at this time. The following day it was noted that the pup had a short ragged length of umbilical cord attached. The pup's coat was light brown and woolly, and it moved about quickly using the anterior edges of its fore-flippers to push against the snow. It sucked strongly from the female. The male seal was much disturbed by the presence of men and moved restlessly about, making bubbling and hissing sounds. It was bleeding from cuts round the mouth. The female was unperturbed by the male's behaviour and human presence. The following day an attempt was made to measure the pup using a calibrated string; this caused much disturbance and the measurement was inaccurate. Afterwards animosity between the male and female was apparent when the male's fore-flipper caught the female's mouth as he rolled over and she tried to bite his flank. On another occasion they both reared up and lunged at each other's heads but no damage was inflicted. On the fourth day of observation the pup lost its cord. It kept close to the female which sometimes used its back as a chin rest, but had virtually no contact with the male. Mouthfuls of snow were sometimes taken and it gave feeble mewing cries. On 24 October, another attempt was made to measure the pup and the accurate straight line nose-to-tail measurement of the pup was 165 cm. However, when the string was being aligned, the male attacked the female and drove her about 100 m. over the ice leaving the pup on its own. The female tried to return to the pup but was thwarted by the male. The pup then moved off, away from the female, to the pool and, on reaching the edge, it spent about 10 min. apparently examining the salty slush before sliding into the water. It stayed on the surface at one spot before swimming slowly towards a small floe where it attempted to climb out. Observations had to be discontinued for an hour and when resumed the pup was found beside a tide crack some distance from the pool. A decision was then made to try and re-unite the pup with its parents. It was sledged over and released on the fast ice on the side of the seals away from the pool so that it would have to pass them on its way there. The pup advanced cautiously towards them as the male made threatening bubbling sounds and, when it was a metre away, the male turned and snapped at its head. The pup defended itself with vigour, using a fore-flipper, and did not retreat. After further attacks from the male, the pup was driven some metres away and gave some plaintive mewing cries. The female showed interest in these proceedings but was unable to intervene because the male was quick to check any movements by her. When observations were concluded that evening, the pup remained some metres away and next morning it had disappeared.

The pup's movements were followed round the island group until it was lost on 30 October. It had covered 8 km. and crossed another open pool during this time. The moult started on the twelfth day of observation with patches of dark hair visible round the eyes, on the proximal parts of the hind flippers and on a small area of the back. When approached at this time it hissed and bared its teeth.

The adult seals remained at the pool where they exhibited intermittent animosity to each other for a further 8 days. They were in frequent close contact with each other and the female's back was covered in dried blood from the male's mouth. On 1 November, the male was seen by itself in an agitated state rearing up and looking about, presumably for the female. The following morning they were both seen together but in the evening the female was alone. The male was then some distance away rapidly heading south across the ice; it was last seen 11 days later lying quietly by a tide crack on the southern limits of the island group. From its tracks, it may have visited the Barros Rocks several kilometres to the south.

At the beginning of November, two other similar crabeater groups were seen in the vicinity of Petermann Island, 8 km. to the north. When one group was approached the male was aggressive. A male pup was seen in the Argentine Islands group on 3 November with the juvenile coat still present on one side of its back and it measured 175 cm. nose to tail. Another older male pup which had completed the moult was seen a few months later on 3 February 1965. In 1959, a similar crabeater seal group was seen in the Petermann Island area, and from the above observations breeding crabeater seals may not be uncommon in some inshore areas on the west side of the Antarctic Peninsula.

Discussion

All eight pups seen with their mothers, that are noted above, were in similar groups of three, each including an adult male. The four new records support Øritsland's (1970) suggestion that the species, like the hooded seal, *Cystophora cristata*, associates in pairs during the breeding period.

Bertram (1940) found that a number of crabeaters over-winter near the west coast of the Antarctic Peninsula. The adult seals at the Argentine Islands had possibly over-wintered in this area and emerged from the pool when the female gave birth. There were several large icebergs near Petermann Island and it seems possible that the seals used tide cracks round these icebergs to gain access to the ice. The fast-ice edge at this time was 15–25 km. to the north-west, probably too far for the seals to have travelled over the surface. Human interference precipitated the break-up of the group and should be avoided in any future observations if a true estimate of the weaning time is to be established. The pup was only seen to suckle for 6 days and its fate was uncertain. Its movements were more agile in comparison with Weddell pups of a similar age, and its cries feebler. It would be interesting to gather further information on the status of breeding crabeater seals in the Argentine Islands area.

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DIVING DEPTHS OF THE GENTOO PENGUIN (*Pygoscelis papua*) AND BLUE-EYED SHAG (*Phalacrocorax atriceps*) FROM THE SOUTH ORKNEY ISLANDS

By J. W. H. Conroy *and* E. L. Twelves

Abstract. Recoveries of a gentoo penguin and a blue-eyed shag from deep water are recorded. Identification of the food in this and four other gentoo penguins suggests that fish are an important part of the species' diet and they can dive to at least 100 m. to capture it. Diving durations and depths of other Antarctic penguins are discussed.

Trammel nets used to obtain fish specimens around Signy Island (lat. 60°45′S., long. 45°38′W.), South Orkney Islands, have also captured a gentoo penguin (*Pygoscelis papua*) and blue-eyed shag (*Phalacrocorax atriceps*). These nets are laid overnight on the sea bed and entangle fish swimming into them (Twelves, 1972); the head line is suspended from a line of floats about 2 m. above the bottom.

Penguin

On 8–9 December 1968, a dead gentoo penguin was taken from a net laid at a depth of 100 m. The species is frequently seen in the locality during netting operations, but it is unlikely that it became entangled near the surface. No struggling, which would have been expected if a 4·5 kg.

bird became entangled, was felt during the laying operation; also, if caught while the net was being hauled in, the bird would still have been alive when taken aboard. Post-mortem examination revealed eight undigested, immature fish *Notothenia gibberifrons*, 90–120 mm. total length; no other food was found in the gut. *N. gibberifrons*, a common *benthic* fish in the area, is usually found at depths of 50 m. or more. Sampling at 100 m., using a 1 m. Agassiz trawl, revealed many fish of this size range. It therefore seems probable that the penguin was taken while catching fish on the sea bed.

A further four gentoo penguin stomachs were examined on Signy Island. All contained fish, over 75 per cent of which were identified as *N. gibberifrons*. Euphausids were found in two guts and four small cephalopod beaks were found in one gut. Digested fish remains and euphausids have been found in the guts of young gentoo penguins.

No detailed work has been published on the food and feeding habits of the gentoo penguin. According to the literature, the penguin's diet includes Crustacea, cephalopods, molluscs and fish, both Notothenidae and Scopelidae (Gain, 1914; Murphy, 1936; Bagshawe, 1938; Ealey, 1954; Stonehouse, 1967) and, at least in some areas such as South Georgia, euphausids have been reported as their main food (Murphy, 1936; Stonehouse, 1967). This apparent importance of euphausids in the diet of the gentoo penguin is interesting, because, unlike the other euphausid-eating penguins on Signy Island, the Adélie (*Pygoscelis adeliae*) and chinstrap (*P. antarctica*) penguins, their rookeries have not the same overall red guano colour. Rather the guano is whitish like that of some other fish-eating birds, such as the kittewake, *Rissa tridactyla*. Murphy (1936), discussing the gentoo penguin's diet, remarked that the Scopelidae were deep-water fish, coming to the surface only at night, but since the gentoo penguin, throughout much of its range, feeds only by day (Bagshawe, 1938; Rankin, 1951; van Zinderen Bakker, 1971), they must dive to considerable depths to catch their food.

Boyd (1964) reported that penguins neither dived deep nor went to the sea bottom. However, observations on Antarctic species show that this is not the case. A published record of diving duration in the gentoo penguin is for forced submersion and a maximum of 7 min. was reported (Scholander, 1940). In the Adélie penguin, Wilson (1907) reported dives of up to 45 sec.; Farman timed 17 dives which averaged 1 min. 54 sec. ($\pm$12 sec.; range 1 min. 40 sec. to 2 min. 10 sec.) (Smith, 1959) and an Adélie penguin held under the water for 6 min., although exhausted when released, recovered (Donald, 1895). Kooyman and others (1971), working on the larger emperor penguin (*Aptenodytes forsteri*) recorded diving times averaging between 1 and 6 min., with one bird remaining under water for over 18 min. Their maximum recorded depth was 265 m.

A more detailed study of the feeding habits of the gentoo penguin is necessary before one can be categorical about its diet. The evidence shows that fish are an important part of it and that the birds are capable of diving to capture it at depths of at least 100 m.

The diet of the pygoscelid penguins has been listed as Crustacea, cephalopods and fish, all three being found in the guts of these penguins, possibly with different frequencies. The Adélie and chinstrap penguins are euphausid eaters, feeding on the surface water; the gentoo penguin also dives deeper to take benthic fish.

Shag

On 28–29 January 1971, a blue-eyed shag was recovered from a net laid at a depth of 25 m. Its stomach contained a single fish *Notothenia neglecta*, 230 mm. long. *N. neglecta* is a shallow benthic fish abundant to a depth of 50 m. (Everson, 1970). It also seems probable that this bird was caught while searching for fish on the sea bed.

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