

Just before the eruption, lava was observed to rise rapidly in the Active Vent and, as it reached the rim, the explosion occurred. After the eruption, there was a drop in the general level of the lava lake, which returned to its original level in about 15 minutes. It is believed that a subterranean connection exists between the Active Vent and the lava lake.

An average of 1.6 eruptions per day occurred during December 1978, compared with 3.6 eruptions per day in January 1978 and an average of about 2.5 eruptions daily for the period between December 1972 and January 1976.

The overall pattern of activity at Mount Erebus is unchanged. The small strombolian eruptions are likely to continue as long as the Active Vent is open and connected to the main magma column. Since 1976, there has been no increase in the size of the lava lake; in fact,

the collapse of the north crater wall has probably reduced its overall size. It is apparent from observations made inside the Inner Crater that the lava is perched above the floor of the Inner Crater. A ridge and small levée limit the lava to the northern half of the Inner Crater.

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Investigation of Late Quaternary sediments from Cape Royds–Cape Barne area, Ross Island

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Using samples from three separate deposits on Ross Island, we have completed an investigation of Late Quaternary sediments in the Cape Royds–Cape Barne area. The results of our study, including assessment of the much-debated emplacement of these deposits, are presented in this paper.

Late Quaternary sediments crop out at elevations up to 60 meters in many localities around the McMurdo Sound coastline. These sediments include unconsolidated, but sometimes ice-cored, fossiliferous gravels, sands, and silts. Carbon dating of carbonate and algal material from deposits close to present sea level provide a range of Holocene ages (Stuiver et al., 1978), while the much less common high-level deposits (28.5 to 63 meters in elevation) contain shell material with ages in excess of 47,000 years before the present (BP) (Denton, Armstrong, and Stuiver, 1970). Some of these sediments are in place and were deposited beneath a marine—often a shallow littoral marine—water column. Others were emplaced after glacial transport from deeper water marine sites. Speden (1962) placed this diverse and widely scattered assemblage of sediments in his Taylor Formation.

The three outcrops in the Cape Royds–Cape Barne area that we investigated were first described and discussed by David and Priestly (1914) and Debenham (1920), who noted that they occur at higher elevations

than the other elevated fossiliferous marine muds in the McMurdo Sound area. Basement in this area consists of flows of McMurdo Volcanic Group rocks. The volcanic rocks of the Cape Royds area were extruded at about 0.68 million years BP (Treves, 1968) and those of the Cape Barne area at about 0.96 to 0.80 million years BP (Armstrong, 1978).

Two of the outcrops lie on volcanic rocks at 59 to 63 meters above sea level near Backdoor Bay, between Cape Royds and Cape Barne. The sites were identified as sample collection points VNA-11 and VNA-13 by Briggs (1978). These sediments contain gastropods and lamellibranchs (Hedley, 1916; Speden, 1962), foraminifera (Chapman, 1916; Ward, 1979), ostracodes (Chapman, 1916; Briggs, 1978), and a variety of macrofossil debris (David and Priestly, 1914; Debenham, 1920; Speden, 1962). Carbon-14 dating of shell material provided an age of more than 47,000 years BP (sample Y2643; Denton, Armstrong, and Stuiver, 1970, p. 17).

The third (and southernmost) of the three outcrops (VNA-8; Briggs, 1978, fig. 1) lies at 28.5 to 31 meters above sea level and is located close to Deep Lake and north of Cape Barne (Debenham, 1920). The fossil fauna includes macrofossils (Hendy, Neall, and Wilson, 1969), foraminifera (Ward, 1979), diatoms (Brady, in press), and ostracodes (Briggs, 1978). Carbon-14 dating of shell material provided an age of more than 49,000 years BP (sample Y2642; Denton, Armstrong, and Stuiver, 1970, p. 17). Sponge spicules are very common at all three localities.

Although a relatively minor component in these sediments, foraminifera are abundant and display considerable diversity (Ward, 1979). A total of 26 genera and 86 species of foraminifera were determined. This includes 3 agglutinated, 3 planktonic, and 80 calcareous benthic species. A random census count of VNA-8 (=PNW-3) provided the following dominance figures: *Ehrenbergina glabra*, 51.33 percent, *Cibicides lobatulus*, 14 percent; *Islandiella islandica*, 11.67 percent; *Cassidulinoides porrectus*, 4.67 percent; *Rosalina globularis*, 3.67

percent; *Epistominella vitrea*, 3.3 percent; *Globocassidulina crassa*, 2.33 percent; *Planispirinoides bucculentus*, 1.67 percent; *Globigerina megastoma*, 1.33 percent; and *Pseudobulimina chapmani*, 1 percent. Each of the other 76 species is present in a quantity of less than 1 percent.

Preservation of the entire fauna is excellent and there is no evidence of abrasion. Size analyses of at least one hundred tests of the four most dominant taxa and *Epistominella vitrea* show a wide range of test sizes in each instance. All growth stages are present. These results and the excellent preservation suggest that the population from VNA-8 (=PNW-3) is a near life assemblage. Furthermore, it is interpreted that this ice-cored sediment has not been subjected to resedimentation in either marine or freshwater environments. Consideration of the total foraminiferal fauna and comparison with post-glacial faunas from the Ross Sea suggest an original bathymetry in excess of 100 meters and possibly as deep as 400 meters.

The emplacement of these three outcrops has been much debated in the literature. Were these sediments deposited by marine processes at these sites or were they transported by glacial processes to the western shores of Ross Island? All investigators, including us, agree that the various faunal groups point to an original water depth greater than 100 meters. Hendy, Neall, and Wilson (1969) suggest deposition of sediments and the accompanying fauna at these depths during a late Pleistocene interstadial, after which the basement volcanic rocks and their veneer of marine sediments were lifted by isostatic processes to their present elevation. However, there is no supporting evidence for such uplift. From a consideration of the gross structure of the eastern McMurdo Sound area, depression of basement rocks seems more likely (McGinnis, 1973).

Denton, Armstrong, and Stuiver (1970) do not address the questions of either major tectonic uplift or bathymetry. They state, "the marine beds are assigned to the interval between Ross Sea Glaciations I and II, when McMurdo Sound was free of grounded glacier ice." If we accept their suggestion that these deposits originated between major glaciations, that the sediments are in place and are of deep-water bathymetry (more than 100 meters), and that this part of Ross Island has remained stationary in a vertical sense, we would be forced to propose positive eustatic movements of more than 160 meters in the late Pleistocene.

We do not believe the evidence warrants our making such a proposal. Rather, we favor Debenham's model (1920) whereby deep-water (interglacial) sediments were entrapped in grounded shelf ice and transported to the present site during expansion phases (or marine glaciations) of the McMurdo or Ross ice shelves.

The following history for the Deep Lake sediments (samples VNA-8 and PNW-3) is advanced. The dominantly volcanoclastic sediment, together with its benthic fauna and photic zone planktonic components, is a deep-water marine sediment that was deposited somewhere to the south of Cape Barne during a major interglacial period. The sediment is certainly much older than the minimum age suggested by carbon dating of the biota. It could be as old as 130,000 years BP, but sound evidence is lacking at this time.

During a major phase of marine glaciation (?Ross Sea

Glaciation II of Denton, Armstrong, and Stuiver (1970), the ice shelves grounded to bathyal depths, incorporated marine sediment, lifted it to the surface, transported it northward, and deposited it in the northern Ross Sea. Material carried along the margins of this ice shelf was deposited above sea level, either during this glaciation or, more likely, during the recessional stages of this glaciation. The sediments were stranded in large remnants of former shelf ice. It is also possible that transportation occurred during the more recent Ross Sea Glaciation I of Denton, Armstrong, and Stuiver (1970). However, the fact that significantly different sediment overlies the marine sediments and is correlated with Ross Sea Glaciation I (Denton, Armstrong, and Stuiver, 1970) inclines us toward accepting earlier glacial emplacement. In this connection, it should be noted that while Denton, Armstrong, and Stuiver (1970) place the marine sediments between Ross Sea Glaciations I and II, they do not cite occurrences of deposits from the latter glaciation along the western coast of Ross Island. If these ice-cored marine sediments are indeed related to Ross Sea Glaciation II, they may have been partly eroded or moved during overriding movements of Ross Sea Glaciation I.

From investigation of the foraminiferal fauna, we do not envisage melting, resedimentation, and subsequent refreezing of this particular deposit. Brady (in press) has recorded a deep-water marine diatom flora from VNA-8 (PNW-3). He also recognized a small nonmarine diatom element. He proposed two alternative explanations for the presence of these nonmarine taxa. First, that they developed in coastal freshwater moats during ice shelf recession, a process that also entailed redeposition of the marine sediment. Second, that they were added to the marine sediments during the formation of melt-pools and streams on the ablating surface of the original ice shelf. This latter process must also involve some degree of recycling of marine sediments.

Brady favored the freshwater moat hypothesis and pointed to analogs on the present ice shelf east of Black Island. Both of Brady's arguments are attractive. However, after a detailed survey of sediments and foraminifera in the Deep Lake outcrop, we do not favor the major recycling of this particular succession of sediments.

The samples used in our investigation were collected by V. E. Neall (VNA-8, VNA-11, VNA-13) in 1969 and by P. N. Webb in 1971-72 (PNW-3). Population studies of the foraminifera and the revision of Chapman's foraminiferal systematics (1916) were investigated by Barbara Ward as part of her work on a master's degree. The project has been supported by National Scientific Foundation grant OPP 76-20657 supervised by Peter-Noel Webb.

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Radioactivity Survey in Antarctica, 1978-79

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The 1978-79 season proved to be particularly successful for the Antarctic International Radiometric Survey (AIRS Project), which was based at the Darwin Glacier Camp. The radiation detection equipment used in the previous two years had been upgraded substantially and functioned without interruption throughout the entire season. Unusually good weather and excellent helicopter support allowed us to survey a much larger area than had been possible in any prior year.

On the first day of operations from the Darwin Glacier Camp, we were surprised to detect a significant radiation anomaly near Touchdown Glacier. The source of radio-



Figure 1. AIRS project crew with gamma-ray spectrometer prepare to begin operations at the Darwin Glacier Camp.

activity was found to be thorium-bearing minerals in a placer-type deposit in the Brown Hills conglomerate member of the Windy Gully sandstone. These rocks constitute the lowermost beds of the Beacon Supergroup and are thought to be Devonian in age. Although the deposits are of no commercial interest, they contain concentrations of thorium as high as 0.3 percent in association with rare earths and tin. The thorium-bearing minerals apparently accumulated in depressions on the Kukri Erosion Surface. We found them at two localities six kilometers apart.

Airborne radiometric survey activities continued from 16 November to 22 December 1978, during which time we made several other discoveries. Extensive outcrops of the basement rocks that underlie the Beacon Supergroup were found at the base of Tentacle Ridge. These rocks are mineralized around a number of narrow veins and they are intensely weathered below the contact with the overlying Beacon Supergroup. Here too, the Windy Gully sandstone shows anomalous radioactivity, but at