International volcanological expedition to Deception Island

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When the news arrived that the Deception Island volcano had erupted again, on August 12, 1970, it was clear that for maximum safety the ship support of the various expeditions to the island should be coordinated. Organization of the first International Deception Island Volcanological Expedition (IDIVE–71) was started during September, and despite the brief preparation time it proved successful.

The first group of eight scientists was brought to Deception Island by the Argentine ship *Zapiola* on December 8, 1970. They were Dr. Nestor Fourcade, Dr. Litterio Villari, and Mr. Julio Moreno of the Argentine Antarctic Institute, Buenos Aires; Dr. Peter Baker and Mr. Ian McReath of the University of Leeds, England; Dr. Leonid Govorukha* of the Arctic and Antarctic Research Institute, Leningrad; and Mr. Olav Orheim and Dr. Terence Hughes of the Institute of Polar Studies at The Ohio State University. Dr. Charles Shultz from Slippery Rock State College, Pennsylvania, joined the expedition from USCGC *Burton Island* a few days later. Two Chilean geologists, Messrs. Francisco Munizaga and Hugo Moreno, also worked on the island during December. Thus, scientists from five nations were represented. That Villari was Italian and Orheim Norwegian further underlined the international flavor of the expedition.

Except for the Chileans, who were supported by the *Piloto Pardo*, the members of the expedition stayed at the Argentine base (the only remaining undamaged base on the island), where the emergency house and a smaller building provided adequate shelter. Argentina also provided the food and most of the field supplies, and *Zapiola* supported the expedition from December 8 to December 22. Further field supplies arrived with *Burton Island* and *Hero,* including a rubber inflatable Zodiac boat with outboard engine. The Zodiac was very welcome as it made movement around the island more efficient.

The 1970 eruption was more violent than the 1967 or 1969 eruptions. It covered and partially reactivated the area between the land center and the submarine center of the 1967 eruption (figs. 1–3). About 10 major and numerous minor craters were formed, completely changing the topography of the northern and northeastern part of the island. The new island formed by the 1967 eruption became joined to the main island. Ash was ejected to a height of several kilometers; 4 mm of ash was recorded at Arturo Prat Station, 70 km northeast of Deception Island.

The geologists Fourcade, Villari, Moreno, Baker, McReath, Munizaga, and Shultz spent most of their time studying the 1970 eruption, and they collected samples for geochemical and petrologic laboratory studies. Fourcade and Villari, assisted by Moreno, also made special studies of the fumaroles. Baker and McReath measured the thickness of new pyroclastic material deposited on the island. Shultz investigated the new faults that had occurred inside the caldera rim. These studies are described further in the following accounts. The geologic studies were greatly enhanced by the familiarity with the local

* Dr. Govorukha's report was delayed in the mail and will appear in the September-October issue.

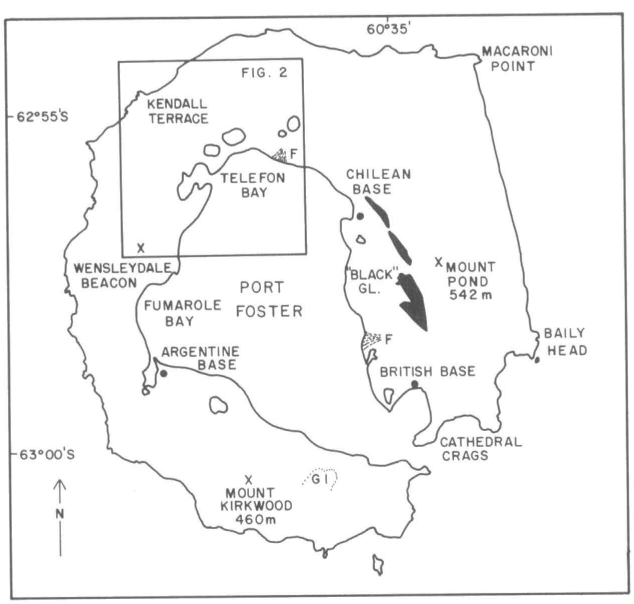

Figure 1. Index map of Deception Island. Solid black areas show locations of 1969 eruption.

conditions developed by Fourcade, Baker, and Shultz from their previous studies.

All the geologists left the island in late December, while the three glaciologists stayed for another month. Orheim, assisted by Hughes, continued the heat, mass balance, and strain studies started during the previous two seasons and initiated a comparative mass balance program at Livingston Island. Studies of the mass balance and volcanic history of the area and of the local ice deformation were made in a glacier crater formed by the 1970 eruption. Govorukha worked part of the season with the Ohio State University glaciologists, but he also conducted several independent studies. He started mass balance studies at two small ice fields near the Argentine base, and he studied firn development at various localities. He also started work on a geomorphological map of the island.

Two other groups of studies, while not an integral part of IDIVE–71, deserve mention. Persons aboard *Zapiola* sounded Port Foster to determine any changes in the submarine topography, and parties were sent ashore to measure tides. Two U.S. biologists from *Hero* studied the changes in marine life that resulted from the 1970 eruption.

As the site of the only erupting volcano in Antarctica, Deception Island will command scientific interest for some time to come. The international cooperation this season will hopefully set a precedent for future expeditions to the area. That the members of this hastily organized expedition were able to work well together and accomplish their scientific objectives bodes well for such ventures in the future.

Petrologic and volcanologic investigation of Deception Island

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The effect of the winter 1970 eruption at Deception Island was less than early reports had suggested. No major volcanic edifice was created, and the caldera wall did not change significantly. However, judging by field evidence, the eruption was the most violently explosive of the recent series of eruptions. This was probably due not only to the high viscosity of the magma but also to massive involvement of cold sea water, which in some craters is still boiling.

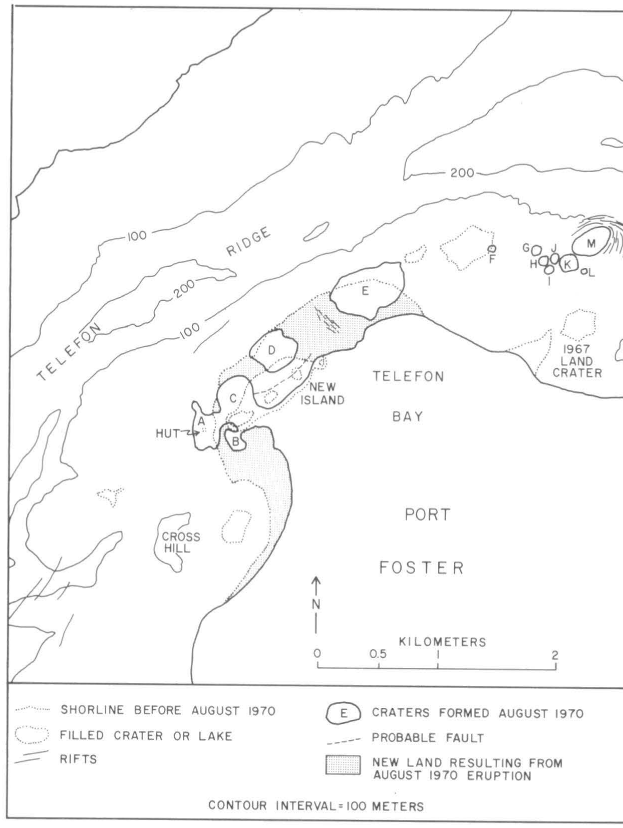


Figure 2. Telefon Bay and the area of the 1967 and 1970 eruptions. Based mostly on sketch may by C. Shultz.

Five new marine craters and seven or eight terrestrial vents, all approximately alined along an arcuate trace 4 to 5 km long, are recognized. The marine eruptions occurred in Telefon Bay and led to the creation of 1.0 to 1.5 sq km of new land (fig. 2). The eruption partially destroyed "New Island" (1967), but pyroclastic deposits have now tied the remnants to the main caldera ring. The marine craters are of the maar type; they are broad and flat with no significant build-up of tephra at their rims. In plan view the maar are scalloped, implying the existence of more than one vent for each maar (fig. 2, crater E).

The land craters generally resemble diatremes. They are narrow, deep, and cylindrical, although later downslope movement has produced a funnel shape. Several (H, J, and K) contained hot, yellowish-green water when examined. Of the group, crater M is of greatest interest, partly because it is the largest but primarily because it broke through a glacial-ice tongue that was heavily mantled with debris. The north side of this crater is distinguished by a remarkable series of concentric slump scarps that presumably resulted from the subsequent flow of ice into the crater (fig. 3). Crater L may be just a fumarole chimney and not an explosive vent. Fumarole chimneys are common in the vicinity of the marine craters.

A tephra blanket covers approximately half of the island, lying north of a line between the former Chilean base and Wensleydale Beacon. The fineness of the tephra has produced a smooth surface texture obliterating most surficial irregularities where the cover is sufficiently thick. This has lent a strange, surrealistic quality to the landscape, especially just west of Telefon Bay. The tephra surface is firm owing to the sea salts that saturate the dust and ash. White salt efflorescence and wetness are common. Meltwater has caused exhumation of some larger stream valleys, but most are still buried. Mudflows originating near the base of snow banks or glacial-ice outcrops are ubiquitous.

Within a few hundred meters of craters, blocks and bombs up to 2.5 m in diameter and numerous impact craters are prevalent. The bombs are generally grayish black with brownish rims and are highly vesicular (black pumice). High viscosity is indicated by jagged tears and other tensional features. The rock is 30 to 70 percent crystalline; glass is partially opacitized by oxidation and turbid due to a dense mat of crystallites. Plagioclase (An_{45-53}) and diopsidic augite are the most common minerals, but forsteritic olivine and orthopyroxene (En_{85-90}) are present in trace amounts. A variety of cognate xenoliths is invariably present, especially in the core of bombs.

The petrographic character of glass shards in ash samples is similar to that of volcanic bombs. Particles are typically equant and jagged. Shard margins cut across vesicles, showing that the ash originated by disintegration of brittle material; the particles are not congealed liquid droplets. Chemical analyses and petrographic characteristics indicate that the new

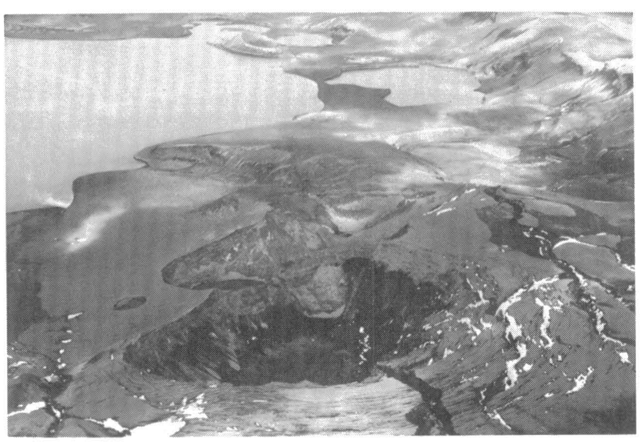
O. Orheim

Figure 4. Stratigraphy of the glacier crater. The scale is indicated by the encircled person and by the 20-m-long crevasse ladder between the arrows. The lower arrow also points to a 0.6-m-thick pyroclastic layer that is possibly from the 1842 eruption reported by Smiley of the Wilkes expedition.

pyroclastics are basaltic andesite in composition and are closely similar to the 1967 and 1969 pyroclastics.

The widespread occurrence of new sea cliffs within the caldera and the active calving of "Black" Glacier imply that the shoreline of Port Foster has subsided; this movement is probably related to the new eruption. Near the Argentine base, the amount of subsidence is estimated to be between 0.5 and 1.0 m.

The most ominous new feature is the presence of numerous open rifts extending from just west of Telefon Bay to the Argentine base toward the southwest. The rifts are best developed west of Cross Hill (fig. 2), where open, *en echelon* cracks 10 to 20 cm wide are more than 100 m long. The rifts cut bedrock as well as sediment deposited during the 1970 melt season, implying that they originated possibly 3 or 4 months after the eruption. They cross the caldera wall at a small acute angle and show a slight vertical displacement, with the interior of the caldera on the up side. It is tempting to speculate that these rifts are the precursors of the next series of eruptions. If so, the next eruptions should occur between the west end of Telefon Bay and the Argentine base.



O. Orheim

Figure 3. View from the east of the area affected by the 1970 eruption. The glacier crater (M) is in the lower center, the former island in the upper center.

Glaciological studies at Deception Island and Livingston Island

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About one-half of Deception Island is covered by glaciers, and in the summer much volcanic dust is blown from the snow- and ice-free areas onto the glacier surfaces. Snow surfaces in the accumulation areas of the glaciers become very dirty by the end of the summer (albedos of 0.3). After these surfaces are buried by the clean winter snow they form reliable annual markers. The annual mass balance history of "Black" Glacier (fig. 1) from 1910 to the present was obtained during the 1969–1970 season by studying the summer surfaces exposed in a 40-m-high wall of a fissure formed by the 1969 eruption. The mass balance history of the area was extended back to about 1750 using the same stratigraphic criteria on 100-m-high walls of a crater (fig. 4) formed by the 1970 eruption in a glacier 5 km north of "Black" Glacier.

The Fourier transform of this mass balance record shows a weak 22-year cycle in the climatic conditions affecting the mass balance. Major changes in mass balances of Northern Hemisphere glaciers can also be recognized in the Deception Island record.

Pyroclastic deposits from eight volcanic eruptions, plus seven questionable volcanic deposits, were found in the walls of the glacier crater. Considered with the evidence of six other eruptions found in the glacier fissure (Orheim, in press) these deposits show a cyclic pattern in volcanic activity for the past 200 years: several eruptions in one decade followed by several decades having no eruptions. Conclusions about cycles, however, are tentative, since the observed layers indicate a minimum number of volcanic events. The pyroclastic deposits record only eruptions that occurred nearby or upwind.

The 1970–1971 glaciological program included several other studies besides the aforementioned crater investigations. The mass balance studies that were started on glacier G 1 (fig. 1) during the 1968–1969 season were continued with small modifications. G 1 is 8 to 10 km from the recent eruptions and is representative of the climatic conditions on the island. The net mass balance averaged over the glacier area was −0.5 m for the 1970–1971 balance year, in contrast to the previous 2 years when the glacier was in approximate balance (Kläy and Orheim, 1969; Orheim, 1970). The main reason for the negative value in 1970–1971 was a large negative summer balance caused by high summer temperatures and an unusually early start of the melt season.

On Livingston Island, 30 km north of Deception, a mass balance program was begun on the small ice cap terminating on Byers Peninsula, on the western side of the island. Numerous density profiles and snow soundings were taken, and 25 mass balance stakes were set. These mass balance studies will show whether the mass balance conditions at Deception Island are representative for the South Shetland Islands. The studies this season indicate that, for the same elevations, the glaciers at Deception Island and Livingston Island experience similar winter balances. Summer balances are more negative on Deception Island, however, because of lower surface albedos at that island's glaciers. The importance of these differences will be better known after the mass balance programs have been continued through the 1971–1972 season.

Other investigations carried out during the 1970–1971 season included meteorological studies at the base camp; meteorological, strain, and borehole temperature measurements on glacier G 1; mass balance and strain studies above the fissure; drilling to the bed of "Black" Glacier from inside the fissure; and mass balance studies east of Pendulum Cove.

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Geological investigations on Deception Island

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The recent series of eruptions on Deception Island (1967, 1969, and 1970) has provided a unique opportunity for studying the style and progress of volcanicity associated with an active caldera fault. Of particular interest have been the migration of the eruptive centers, the compositional variations of the magma in successive phases, and the effects of subglacial and submarine activity. A study of the older formations of the island, using the work of Hawkes (1961) as a starting point, has been an essential corollary to these investigations.

The sequence of recent events has been closely followed by scientists from several nations, including Argentina, Chile, the United States, and the United Kingdom. A team of British scientists supported by the Royal Society and the British Antarctic Survey studied the 1967 and 1969 eruptions (Baker *et al.*, 1969); and the Royal Society provided funds for an extension of these investigations to include the 1970 eruption. On this latter occasion, however, full logistic support was kindly provided by the Argentine Antarctic Institute and the Argentine Navy. We were at Deception Island December 8 to 23, 1970, forming part of the international group based at the Argentine station on Fumarole Bay.

The latest volcanic eruption (Baker and McReath, 1971) occurred on August 12 and 13, 1970, as inferred from seismic data and the time at which ash fell on Greenwich Island (Capitán Arturo Prat Station) and King George Island (Bellingauzen Station). The activity created a new strip of land across Telefon Bay from Cross Hill in the west to the 1967 land center in the east. The arcuate distribution of the vents seems to have been determined by the caldera fault zone. The new land area is for the most part only a few meters above sea level, and lagoons or lakes occupy several of the craters. The small island that had formed during the December 1967 eruption was partially destroyed in this latest episode, and its remnant was incorporated into the new strip of land. The crater lake of the 1967 land center was obliterated by a mudflow generated at a new crater in the glacier above. Two older lakes were also drained as a consequence of the physiographic changes.

The products of the 1970 activity, like those of the two previous events, were entirely pyroclastic; an isopach map for these deposits was compiled largely on the basis of depths to the snow surface over Kendall Terrace. The ash was evidently distributed under the influence of a southwesterly wind, the finer material being carried northeastward along the length of the South Shetland Islands. The variation in chemical composition of the pyroclastics and its apparent relationship to the geographical situation of the source vent suggests control on a very local scale.

Laboratory work has included the examination of some 60 samples—in thin section and by major and trace element analysis—from a wide range of the rocks exposed on the island. On this basis, about 20 samples have been selected for further study, analyzing for a further set of trace elements by optical spectrography and for initial strontium isotope ratios. We also hope to develop a technique for analyzing the rare-earth elements and, if this is successful, to analyze a few samples for these elements. A program of mineral analysis using both separated minerals and electron microprobe analysis is under way.

We gratefully acknowledge the generous support received from the Argentine Antarctic Institute, the Royal Society, and the British Antarctic Survey.

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Volcanic evolution at Deception Island: studies during 1970–1971

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During the 1970–1971 summer, the Argentine Antarctic Institute, in association with the International Institute of Volcanology at Catania, Italy, carried out scientific work at Deception Island. Activities involved a structural volcanological study of the island and a magmatic study of the lava flows in the area. Both studies are helping us to determine the evolution of the volcano from its beginnings to its present state. Samples of materials ejected from the 1970 eruption were collected, temperatures were measured, and the 1970 morphological changes were plotted on maps.

The character of the eruption, like the two previous ones, was merely explosive, with abundant ejection of volcanic bombs, lapilli, ashes, and water vapor.

Kendall Terrace was completely covered by an ash mantle, lapilli, bombs, and rock fragments that emerged from the volcanic neck. The islet that emerged during the eruption in December 1967 is now reduced to a small promontory located onshore, and its interior craters have disappeared.

Lava samples from the 1970 and previous eruptions are being analyzed at the laboratories of the Argentine Antarctic Institute and the International Institute of Volcanology at Catania.

1970 eruption at Deception Island: distribution and chemical features of ejected materials

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A desire to obtain knowledge of the changes produced by the August 12, 1970, eruption at Deception Island motivated investigators from the University of Chile and the Chilean Antarctic Institute to undertake a new study. Messrs. Francisco Munizaga and Hugo Moreno were sent to Deception Island, where they remained from the 9th to the 20th of December 1970. They were assisted logistically by Chilean helicopters and the Chilean ships *Piloto Pardo* and *Yelcho*.

The party studied and mapped the morphological changes produced during the August 12, 1970, eruption, constructed an isopach showing the distribution of ejected materials, and analyzed samples of ejected materials to determine their chemical and petrological features. Only the latter two facets of this work are reported here.

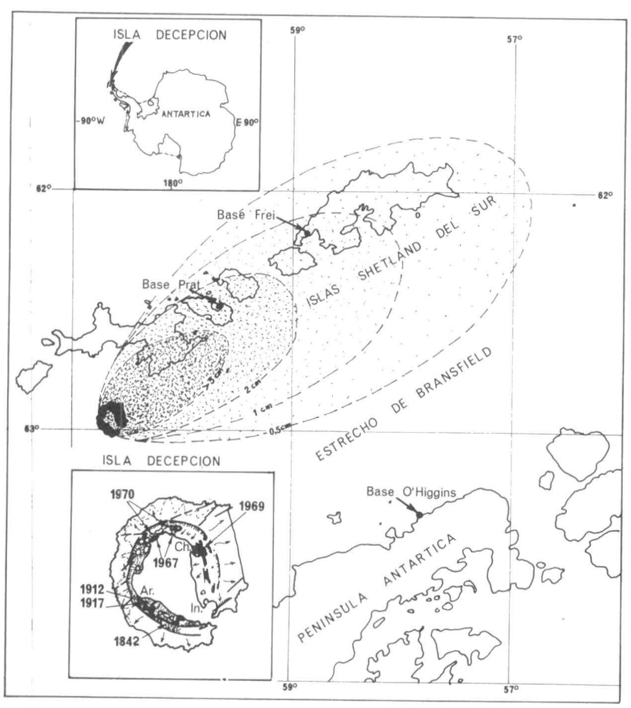

Figure 1. Index map of Deception Island. Shown also are distribution and thickness (in cm) of ash and lapilli during the August 12, 1970, eruption. Insert shows locations of historical eruptions.

Reports of several stations in the Antarctic Peninsula were used to construct the isopach shown in fig. 1.

Petrographic and chemical analyses of ejected materials

The materials ejected during the August 1970 eruption were exclusively of the pyroclastic type, lapilli and ash predominating over bombs and blocks. Their characteristics are similar to those of the 1967 eruption. The pyroclastics are generally dark gray to black, the bombs highly vesicular and often pumice-like inside with inclusions of preexistent basaltic and andesitic rocks. The composition in general is andesitic, normally aphyric, and only occassionally containing some phenocrysts of plagioclase.

The bombs analyzed are petrographically very similar. The description of some (samples Y–10, Y–11, Y–13), possibly the ones most representative of the 1970 eruption, and their chemical analysis (table 1), indicate clearly their andesitic character.

Table 1. Chemical analyses[1] and norms of volcanic rocks from the August 12, 1970, eruption of Deception Island.

Element or rock type	Y-10[2]	Y-13[3]
SiO_2	57.53	56.90
TiO_2	1.64	1.80
Al_2O_3	17.00	15.10
Fe_2O_3	1.99	1.88
FeO	5.03	6.59
CaO	7.00	7.50
MnO	0.17	0.04
MgO	2.20	2.60
Na_2O	6.27	6.40
K_2O	1.20	1.00
P_2O_5	0.21	0.18
ppc	0.31	0.58
Total	100.55	100.57
	C.I.P.W. norms	
Qz	0.36	—
Or	7.23	6.12
Ab	52.92	52.40
An	14.73	9.45
Di	15.83	22.30
Hy	2.72	—
Ol	—	2.40
Mt	3.02	2.75
Il	3.04	3.50
Ap	0.33	0.33
Ne	—	0.85

[1] Performed by Miss Gloria Moreno.
[2] Andesitic bomb from the edge of crater 9; August 12, 1970, eruption.
[3] Andesitic bomb from the INACH crater; August 12, 1970, eruption.

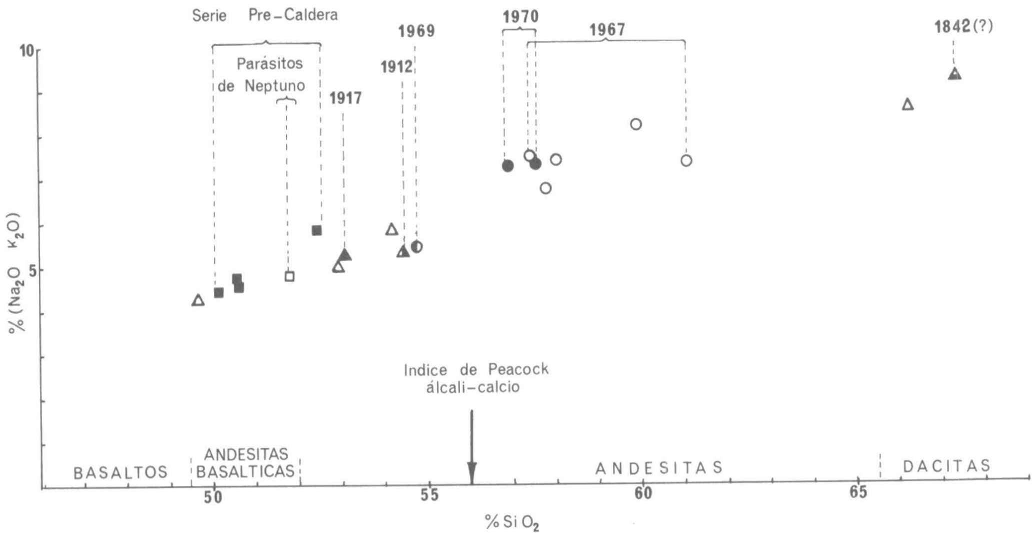

Figure 2. Diagram of (Na_2O+K_2O) versus SiO_2 of the volcanic rock series from Deception Island. The arrow indicates the alkali-calcic index of Peacock.

They are characterized by their scoriaceous aspect—very vesicular and sparsely porphyritic—with phenocrysts of plagioclase (An_{50-60}), clinopyroxenes (augite), and magnetite with a basic hyalopilitic ground mass, dark brown in color, with a refraction index of 1.555 and microlites of plagioclase and clinopyroxene. The absence of olivine in these rocks is noteworthy. Their vesiculation ranges between about 20 and 40 percent. A modal recount of three bombs is given in table 2.

The chemical analyses and norms of two of these samples are given in table 1. While they show close similarity with those of the eruptions in 1967 and 1969, there is a small variation in their chemical composition. The silica content is a median value, being slightly more basic than that of Yelcho Island (61.18 percent SiO_2) and more siliceous than that of 1969 (54.80 percent SiO_2). However, its high soda content is maintained—as pointed out by various authors—in the pre- as well as postcaldera series of Deception Island.

Variation in chemistry with time of extrusive rocks

To determine historical trends in the chemical character of the Deception Island extrusive rocks, 20 chemical analyses of lava as well as pyroclastics were selected from those pertaining to volcanic units whose chronology is well controlled. These analyses, published by Hawkes (1961), Baker *et al.* (1969), González and Katsui (1970), Valenzuela *et al.* (1970), and Orheim (in press), have been projected in a diagram of alkali ($Na_2O + K_2O$) versus SiO_2 (fig. 2). The projected points permit the tracing of a curve of uniform dip whose limits range between 49.8 and 67.0 percent of SiO_2. Also, the more basic character of the precaldera series is evident, composed of lavas and basaltic and andesitic-basaltic pyroclastics whose content of SiO_2 ranges between 49.8 and 52.3 percent. The postcaldera series is less basic and shows a noticeable enrichment in silica that varies approximately from 52.5 to 67.0 percent. An oscillation between 54.9 and 61 percent of its content is observed in Deception Island.

The alkali-calcium index of Peacock (1931) for the volcanic rocks of Deception Island gives a value of 56, which corresponds exactly to the limit between the alkali-calcic and calc-alkalic series. However, this value is slightly lower than the common integral value given for Upper to Recent Cenozoic volcanism in the South Shetland Islands, which is 56.5, as shown by Vergara and González (in press) and González and Vergara (in press), and which according to the classification of Peacock presents a calc-alkalic chemical character for this volcanism in the South Shetland Islands.

Table 2. Modal analysis of three bombs from Deception Island.

Content	Sample Y-10	Sample Y-11	Sample Y-13
Plagioclase	10.0	14.0	14.0
Pyroxenes	2.0	2.5	4.2
Magnetite	1.9	1.7	1.6
Ground mass	86.0	81.8	80.1

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Nonhomogeneous strain studies on antarctic glaciers

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Evidence for nonhomogeneous strain exists as shear bands in a Deception Island glacier exposed internally during the August 12, 1970, eruption and as a surface wave train on Meserve Glacier in Wright Valley, south Victoria Land (fig. 1). Deception Island and Meserve Glacier have been sites of extensive studies by glaciologists from The Ohio State University's Institute of Polar Studies.

The major Deception Island glaciological program is described by Mr. Olav Orheim in this issue. My independent study concerned shear bands on the ice walls of a 1970 eruption crater located at the snout of a glacier originating in the vicinity of Binon Hill. The crater is about 300 m in diameter and increases from about 50 to 100 m in depth as one proceeds up the glacier. Lying at the very tip of the glacier and slightly to one side of the central flowlines, the crater has exposed annual dirt layers and ash layers from previous eruptions. It is being closed by ice flowing inward from all sides as predicted by the theory for contraction of a cylindrical hole (Nye, 1953), modified by the crater shape, ice thickness variations, and the glacier velocity field.

Fig. 2 illustrates the mechanism whereby the crater is being closed. Near the snout the glacier is apparently frozen to its bed, and ice flowing inward has generated a bending moment that is shearing the ice along steeply rising surfaces that intersect the crater wall at acute angles. Shear appears largely confined to either individual planes or to narrow bands, and the amount of shear can be measured from the displacement of dirt and ash layers that intersect the shear surfaces. This measurement was done for one wall of the crater, giving most of the shear deformation that has been closing the crater since the eruption. Air bubbles are often elongated in the direction of flow and generally aline parallel to the annual dirt layers. However, when these layers intersect shear surfaces, the air bubbles become elongated in the shear direction for wide ($\approx$ 5 cm) shear bands but not for narrow ($<$ 1 cm) shear bands. This indicates that wide bands formed slowly and that narrow bands formed rapidly.

The major Meserve Glacier glaciological program consisted of relogging boreholes drilled in 1968–1969 as part of Dr. Gerald Holdsworth's glaciological investigation. Holdsworth relogged the holes in 1969–1970. My independent studies concerned the surface wave train. Apparently, two mechanisms contribute

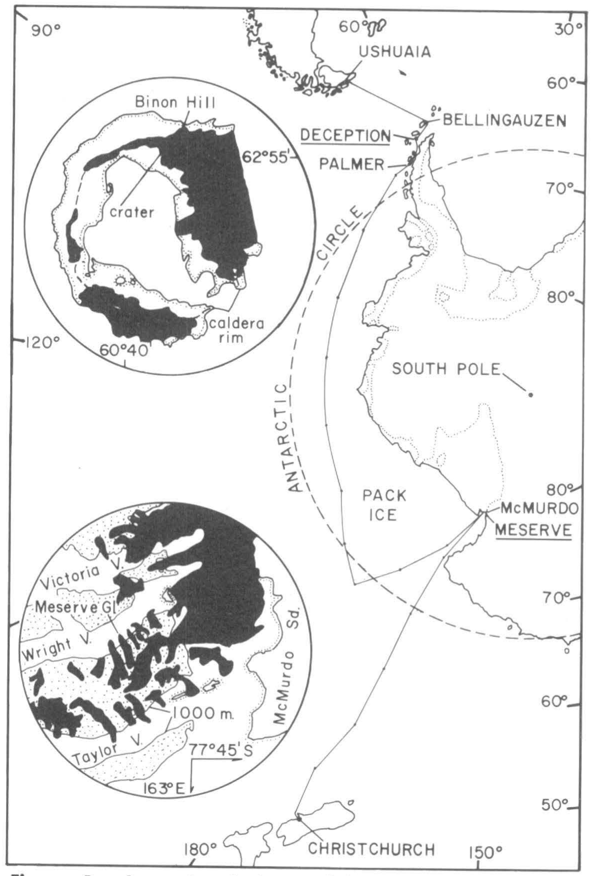

Figure 1. Antarctic glaciers exhibiting nonhomogeneous deformation (shown in black) on Deception Island (top inset) and in the dry valleys (bottom inset). Transit was by the Argentine ship *Zapiola* from Ushuaia to Deception Island, by R/V *Hero* onward to Palmer Station, and by USNS *Wyandot* onward to McMurdo Station and Christchurch.

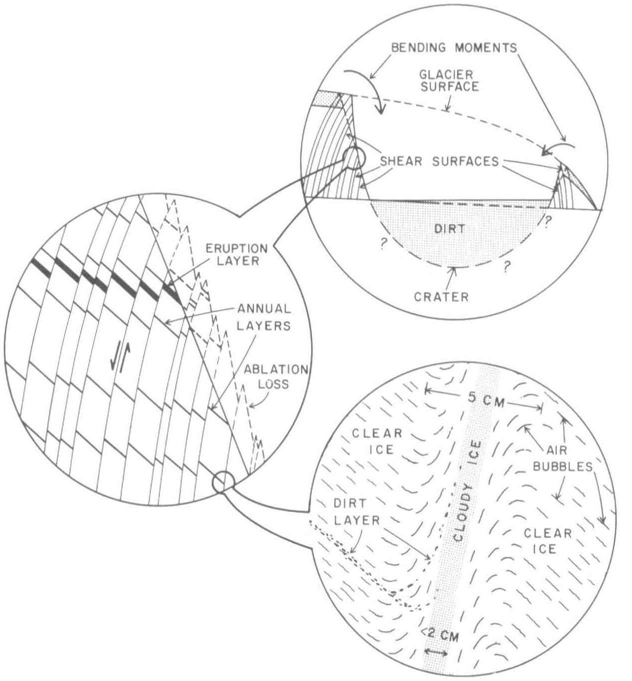

Figure 2. Shear surfaces created around the ice wall of the Deception Island crater (fig. 1). Top circle shows general structure of crater in the glacier. Center circle shows how shear surfaces displace ash and annual layers. Bottom circle shows how elongated air bubbles become reoriented by the wider shear surfaces.

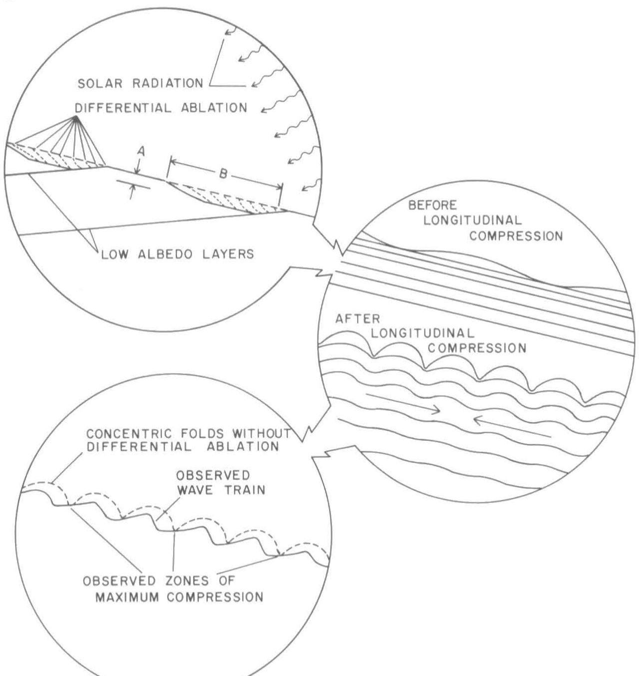

Figure 3. Postulated evolution of surface wave trains on Meserve Glacier and other northward flowing dry valley glaciers of fig. 1. Top circle shows that differential albedo between low- and normal-albedo ice layers determines *A* and *B* amplitudes of differential ablation and that layer spacing determines periodicity. Troughs are created by greater ablation rate of ice receiving solar radiation at high angles. Center circle shows how longitudinal compression transforms a sinusoidal surface perturbation caused by differential ablation into a series of concentric folds. Bottom circle shows how the varying incident angle of solar radiation differentially ablates the concentric folds to form the observed wave train profile.

to the formation of surface wave trains on dry-valley glaciers: an instability mechanism activated during the antarctic winter for glaciers having ice falls (Holdsworth, 1969) and a differential ablation–longitudinal compression mechanism that operates on glaciers that have ogives and flow northward (Hughes, 1971).

Fig. 3 illustrates the differential ablation–longitudinal compression mechanism whereby a glacier wave train might be formed. Low albedo layers (dirty layers from the accumulation basin or low air bubble layers from collapsed crevasses) intersect the ablation surface, and more rapid ablation of the low albedo layers creates notch bands along the lines of intersection. If the glacier receives high-angle solar radiation (northward flowing glaciers in Antarctica), the rear surface of the notch ablates upstream since it receives the most intense solar radiation. In this way, a somewhat sinusoidal surface perturbation is created, with the amplitude determined by the ultimate depth of ablation into the low albedo layer and the wavelength determined by the surface spacing between these layers. Longitudinal compressive stresses transform the sinusoidal surface perturbation into concentric folds, increasing the amplitude and decreasing the periodicity. Differential ablation acts simultaneously to modify the concentric folds, resulting in the observed wave train profile.

Studying independently during phase 3 of the Meserve Glacier investigation (see p. 127), Mr. Maurice McSaveney of The Ohio State University Institute of Polar Studies constructed a closely spaced surface strain network between borehole sites G 4 and G 5. This network shows that maximum compressive strains are on the wave terraces at sites where concentric folding, unmodified by differential ablation, may have occurred.

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