Scallop Hill Formation and associated Pliocene marine deposits of southern McMurdo Sound

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Our fieldwork in southern McMurdo Sound during the 1978–79 austral summer, together with fieldwork in 1977–78, has revealed several distinctive lithofacies of Scallop Hill Formation sediments. These and other findings are incorporated into the following account of the Scallop Hill Formation.

This formation is a fossiliferous, marine, volcaniclastic conglomerate and tuff occurring in southern McMurdo Sound. The type locality lies atop Scallop Hill (223 meters) on the eastern edge of Black Island, where it was considered to be in place (Speden, 1962). Blocks of the formation are present in latest Tertiary and Quaternary glacial deposits around the McMurdo Sound area (figure 1), but the thickness and areal extent of the Scallop Hill Formation is unknown.

The Scallop Hill Formation is characterized by the presence of an extinct, thick-shelled pelecypod, *Chlamys* (*Zygochlamys*) *andersonni* Henning. Other associated fossils include serpulid worm tubes, encrusting bryozoans, echinoderm fragments, diatoms, sponge spicules, and benthic Foraminifera. It is possible that the Scallop Hill Formation is the same age as the Pecten gravels of Wright Valley. Webb (1974) suggested a Pliocene age for both the Pecten gravels and the Scallop Hill Formation. The Pecten gravels were interpreted as having been deposited under interglacial conditions in a marine environment (Webb, 1972, 1974).

Reconstruction of the blocks at the type locality of the Scallop Hill Formation (figure 2) revealed a stratigraphic thickness of about 85–90 centimeters. This measurement is based on a fossiliferous layer containing pectens (oriented predominantly convex side up) and an overlying coarse, tuffaceous conglomerate, which is possibly reverse graded. One or both of these marker beds are found in all of the larger blocks of consolidated sediments. Upon digging under the blocks, we discovered that they rest on the moraine that veneers the trachyte flow at Scallop Hill. There was no indication that the blocks are in place as suggested by Speden (1962). Many human visits to this locality in recent years no doubt have resulted in modification of its original nature.

Speden (1962) proposed that the blocks on Scallop Hill are the remnants of a more extensive deposit that has been scattered around the McMurdo Sound area in the course of subsequent glaciations. In a study of topographic benches, Vella (1969) interpreted the occurrence of the Scallop Hill Formation sediments on one

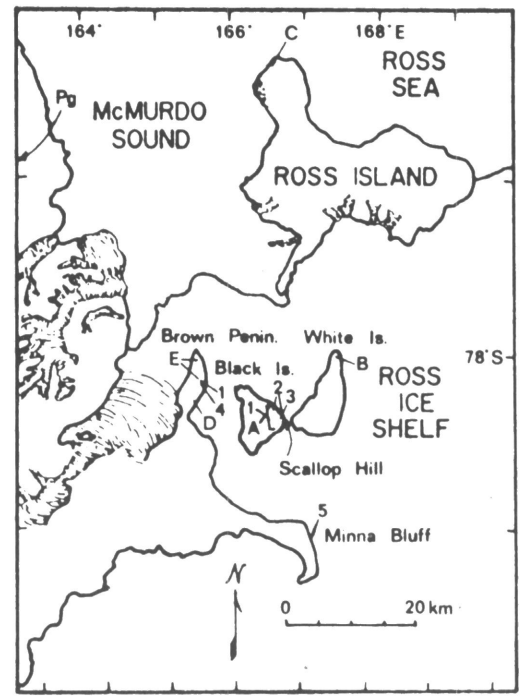

Figure 1. Map of the McMurdo Sound area. The numbers refer to lithofacies of Scallop Hill Formation sediments discussed herein: 1 = *tuffaceous facies;* 2= *volcaniclastic conglomerate facies;* 3 = *concrete facies;* 4 = *Brown Peninsula facies;* and 5 = *Minna Bluff facies.* Letters refer to other Scallop Hill Formation localities discussed in previous studies: A,B,C,D = Speden (1962); E = Vella (1969). Pg refers to the Pecten gravels of central Wright Valley (Webb, 1972 & 1974). Map redrawn from Foster and Bruchhausen (1977).

particular topographic surface to be indicative of a second of four climatic cycles he recognized on Black Island and Brown Peninsula. In addition, he stated that the Scallop Hill Formation could be mapped for "considerable distances" on both Black Island and Brown Peninsula and concluded that this was "almost certainly an in situ water-laid layer buried by the moraine." He omitted to discuss and describe the nature of the occurrences of the Scallop Hill Formation.

Our experience has shown that Scallop Hill Formation sediments occur in glacial dumps, ice-cored moraines, loose boulders on morainal pavement, and also in a few localities suggestive of an in situ nature with subsequent modifications by frost action.

A preferred explanation for the mode of occurrence of the consolidated sediments on Scallop Hill involves glacial transport during a Ross Sea Glaciation and deposition as erratics. The distance of transport may actually be very short. Glacial striations on the trachyte at the summit of Scallop Hill range in orientation between north 8° east and north 20° east. A glacial advance of the Ross Ice Shelf moved northward along the eastern coast of Black Island, scoured the surface of the trachyte, and sculptured the rounded profile of Scallop Hill and the adjacent saddle (figure 3). This is in agreement with ice movement directions postulated by Denton based on Ross Sea Glaciation moraines on Black Island (pers. comm.). A potassium-argon age of 4.4 ± 0..06

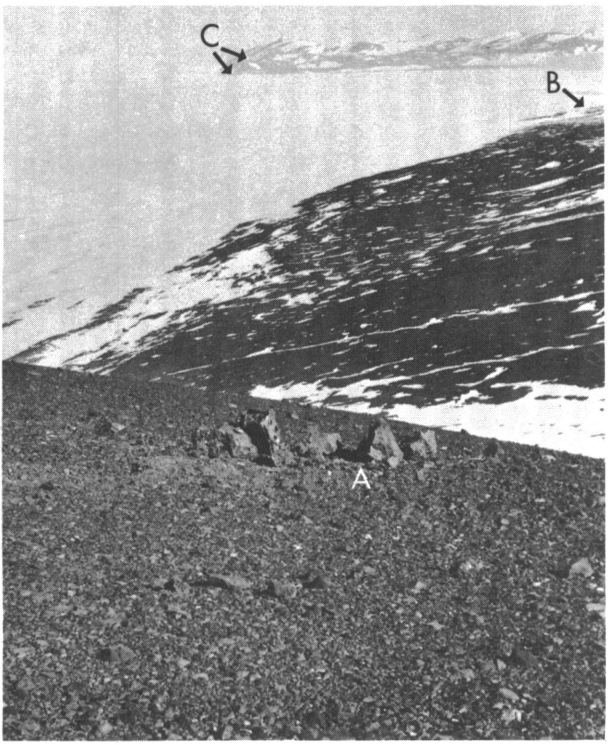

Figure 2. The type locality of the Scallop Hill Formation atop Scallop Hill. The present disposition of the blocks is caused from repeated sampling in recent years (A). View looking south over the eastern coast of Black Island. Many glacial dumps of tuffaceous material are found along this shoulder. A north-south trending moraine of similar tuffaceous material can be seen farther south. B is Minna Bluff in background. C refers to the approximate positions of the *Minna Bluff facies.*

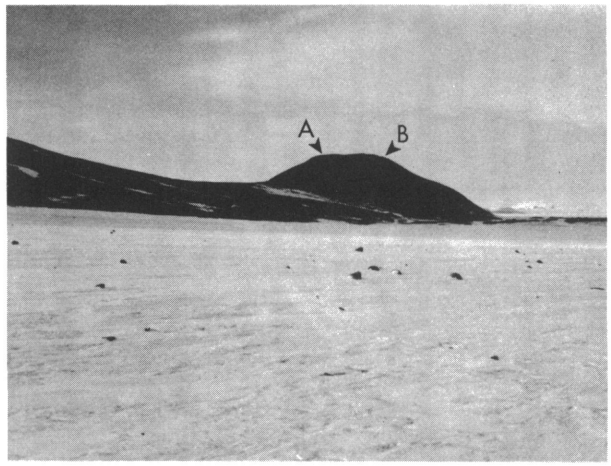

Figure 3. Sculptured profile of Scallop Hill and the adjacent saddle on the eastern coast of Black Island. View looking north with a cloud-covered McMurdo Station in the right background. A is the type locality of the Scallop Hill Formation. B is the approximate position of glacially scoured trachyte.

Figure 4. Typical glacial dump of pecten-bearing *tuffaceous facies.* View looking southeast with Scallop Hill in the background. This particular deposit is in the form of a drumlin trending northeast. Arrow designates the approximate position of the type locality of the Scallop Hill Formation.

million years was obtained from the trachyte (Sutter, pers. comm.), implying that what may be termed a Scallop Hill Glaciation postdates the early Pliocene.

Neither Speden (1962) nor Vella (1969) differentiated the Scallop Hill Formation sediments into various lithofacies, although Speden did note that there was a wide range of grain size and color. Our fieldwork during the 1976–77 and 1978–79 seasons revealed several distinctive lithofacies.

The type locality of the Scallop Hill Formation represents a tuffaceous facies. It is characterized by a dusky yellow tuffaceous matrix, but it may also contain a high percentage of volcanic clasts ranging in size from coarse sand through cobbles. This facies also is found in scattered glacial dumps and drumlins (figure 4) and in loose boulders and ice-cored moraines along the eastern edge of Black Island.

Many glacial dumps of tuffaceous material occur along the shoulder of Black Island south of Scallop Hill. A north-south moraine of similar tuffaceous material extends farther south from the shoulder and out onto the Ross Ice Shelf. This deposit appears to have been lifted or pushed up from the adjacent sea floor by grounded shelf ice. Although this deposit is barren of macrofossils, examination for microfossils may allow correlation with the Scallop Hill Formation and possibly a better understanding of the mode or modes of emplacement of these volcaniclastic sediments.

The volcaniclastic conglomerate facies also is found on the summit of Scallop Hill, but it is concentrated 2.5 kilometers to the north on a slope along the coast of Black Island (lithofacies 2 in figure 1). This facies is characterized by a black color, which is produced by clasts of basalt and a low proportion of fine matrix material. The conglomerate is very hard and contains

abraded pecten valves. The exposure on the north side of Scallop Hill occurs within the moraine, so that its thickness and extent are uncertain. It is possible that these exposures are in place or have been transported only a short distance within ice-cored moraine.

The concrete facies (figure 1) is indurated and has a characteristic gray color owing to its high content of fine material. The clasts are predominantly rounded volcanics with subordinate plutonics. This facies was found almost exclusively within the saddle west of Scallop Hill and is either concentrated in glacial dumps or is associated with glacial deposits of the tuffaceous facies. Several boulders of consolidated conglomerates also showed a contact between the concrete and volcaniclastic conglomerate facies, suggesting an interbedded nature in the original sedimentary deposit. The tuffaceous facies also is found in scattered moraines on the east side of Brown Peninsula (figure 1).

In addition, the authors noted another distinctive fossiliferous volcaniclastic congomerate here termed the Brown Peninsula facies, which is probably the same as Vella's MS135 locality. It is characterized by a high percentage of felted aragonite cement and abraided pectinid valves. The clasts are predominantly basaltic with subordinate trachyte. This nearly horizontally distributed deposit is exposed over an area roughly 50 × 30 meters. Its thickness and relationship to the surrounding moraine are uncertain, although it may be close to its point of origin.

The northeastern corner of Minna Bluff has its own distinctive fossiliferous, volcaniclastic conglomerate, known as the Minna Bluff facies. This closely resembles the Brown Peninsula facies, but the carbonate cement and pectinid valves are iron-stained, giving the rock a characteristic black and orange color. Fragments of this facies were found scattered widely in moraine from near ice shelf level (about 175 meters) up to the top of a volcanic ridge (about 400 meters). No glacial deposits containing a concentration of this variety were found.

It appears that the type locality of the Scallop Hill Formation actually represents only a small part of a fossiliferous marine sedimentary deposit. Scallop Hill Formation sediments probably were deposited on the marine flanks of the volcanic islands and peninsulas of southern McMurdo Sound. Fossiliferous beds are interbedded with volcaniclastic and tuffaceous units and possibly hyaloclastite deposits. The five pecten-bearing facies are possibly contemporaneous, but local variations in sediment source have resulted in distinctive lithologic characteristics.

The presence of pelagic diatoms indicates that there were ice-free conditions at least part of the year in southern McMurdo Sound. This assumes that the diatom flora has not been recycled. Faunal evidence suggests deposition of the volcaniclastics during mid-Pliocene interglacial conditions. Deteriorating climatic conditions and expansion of the Ross Ice Shelf between the middle and late Pliocene would have then covered southern McMurdo Sound with perennial ice; this would have inhibited marine productivity. A major glacial advance (noted from several localities around Antarctica) has been postulated to be coincident with the onset of the Matuyama epoch 2.4 million years ago (Anderson, 1972; Fillon, 1975; Hayes and Opdyke, 1967).

Subsequent grounding of the Ross Ice Shelf could have incorporated indurated blocks of volcaniclastic sediments and transported them intact to their present subareal positions. This is evidenced by glacial deposits and loose boulders found in the moraine. Some of the volcaniclastics that are contained within ice-cored moraine may actually be close to their original site of deposition, but subsequently they have been fragmented by frost action. Other volcaniclastics may represent marginal marine deposits that have been heaved up above sea level along the ice shelf contacts with the volcanic islands.

We are presently undertaking detailed faunal studies and expect that the results will allow us to develop a better resolution of age, correlation, and relationship among the various facies.

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