GEOLOGIC MAP OF ANTARCTICA

SHEET 18, MARIE BYRD LAND

EXPLANATION

- Cenozoic — Crv — *Volcanic rocks*
- Tertiary? — Tv — *Tuffs and basaltic lava flows*
- *Unconformity?*
- Cretaceous — Kg — *Felsic intrusive rocks*
- pKv — *Metavolcanic rocks*
- Cretaceous or older — pKq — *Shepard Island quartzite*
- pKs — *Metasedimentary rocks*
- *Unconformity?*
- Pre-Cretaceous — pKg — *Undifferentiated gneisses (basement complex?)*

- Geologic contact (mainly inferred)
- Limits of landforms rising above the surface of the surrounding ice with varying amounts of rock exposure
- Inferred fault, displacement unknown
- 47 — Strike and dip of bedding
- Anticline
- Inferred anticline, with direction of plunge
- Syncline, with direction of plunge
- 100 Kb — Radiometric age determination showing age in m.y., method (K=K–Ar, R = Rb-Sr), and material (b=biotite, f=feldspar)
- Approx. coastline
- Ice-flow lines
- Ice shelf
- Edge of ice tongue

Sources of base map:
Saunders Coast, Hobbs Coast, preliminary compilations, 1:500,000, U.S. Geological Survey; Antarctica 1:250,000 Reconnaissance Series, U.S. Geological Survey (1963)

* Names usec are those approved by the United States Board on Geographic Names unless marked with an asterisk

TABLE 1. RADIOMETRIC AGE DETERMINATIONS

Location	Lithology	Method and Material	Age (m.y.)	Ref.
Mt. Atwood 77°16'S, 142°17'W	Adamellite	K-Ar Biotite	143±4	1
		Rb-Sr K-feldspar	137±9	
Mt. Jackling 77°52'S, 154°58'W	Granite	K-Ar Biotite	104±4	2
Mt. Paterson 78°02'S, 154°36'W	Granite (basic segregation)	K-Ar Biotite	102±4	2
Breckinridge Peak 78°04'S, 155°07'W	Schist	K-Ar Biotite	102±3	2
Fosdick Mts. 76°34'S, 144°41'W	Biotite gneiss	K-Ar Biotite	95±5	2
Tennant Peak 78°09'S, 155°18'W	Granite	K-Ar Biotite	92±5	2
Mt. Sidley 77°02'S, 126°00'W	Andesite	K-Ar Plagioclase	6.2	3

1. Boudette, et al., 1966
2. C. Craddock, personal communication
3. Doumani, 1964

Geology of Marie Byrd Land

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Introduction

That part of West Antarctica known as Marie Byrd Land is in reality an archipelago that is separated from East Antarctica and possibly from the Antarctic Peninsula by a strait called the Byrd Subglacial Basin. The continental ice sheet extends over both the land and adjacent basins, giving the impression of a continuous land mass. Limited ice-thickness measurements indicate that the archipelago consists of a large island, 1100 km long in an east-west direction and 280 km wide, and six or more small islands, each less than 120 km in greatest dimension. The elevation of the surface of the ice sheet in the part of Marie Byrd Land shown on the map reaches a maximum on the long axis of the main island. It attains elevations of more than 2500 m in the vicinity of the Executive Committee Range. The ice surface slopes gently downward in all directions from this central highland, and the ice flows outward in the directions of the surface slope. Along the eastern shore of Sulzberger Bay, the Ford Ranges restrain this plateau ice, which discharges into the frozen bay only through outlet glaciers transecting the ranges. On Edward VII Peninsula, a thumbshaped western extension of the main island, the ice surface slopes away in all directions from the Rockefeller Mountains, where peak elevations are somewhat above 500 m. Although more than 90 percent of the map area is blanketed by ice, bedrock exposures, particularly in the Ford Ranges and Edward VII Peninsula, are adequate for detailed studies of the major geologic features.

Marie Byrd Land was discovered and named by Rear Admiral Richard E. Byrd during an exploratory flight from Little America in 1929 (Byrd, 1933). Edward VII Peninsula was discovered in 1902 by Robert F. Scott (Scott, 1903). Scott also sighted the Alexandra Mountains and Scott Nunataks from his ship but was unable to put a party ashore to investigate the rocks which crop out on their slopes. In 1910 Prestrud, a member of the Amundsen South Polar Expedition, led a field party to Scott Nunataks from Framheim on the Bay of Whales (Prestrud, 1913). The rocks he collected were later described by Schetelig (1915). During the Byrd Antarctic Expedition in 1929 Washington Ridge in the Rockefeller Mountains was visited by L. M. Gould (Gould, 1931). A field party from the Second Byrd Antarctic Expedition, 1933–1935, under the leadership of Paul Siple and including the writer, made the first geological survey of the Ford Ranges (Wade, 1937a, 1937b) and also visited Washington Ridge. During the United States Antarctic Service Expedition, 1939–1941, L. A. Warner and his field party made a more detailed study of certain portions of the Ford Ranges (Warner, 1945; Passel, 1945). During the same season L. M. Berlin led a land survey party to the Flood Range, where they collected a few specimens from Mt. Berlin; a geological survey of the Rockefeller Mountains was also made by the writer (Wade, 1945). Thin sections of plutonic rocks from the Rockefeller Mountains and the Ford Ranges were described by Stewart (Stewart, 1934, 1941, 1945). The next group to explore Marie Byrd Land was an oversnow traverse party from Byrd Station in 1959. G. A. Doumani, the geologist with the party, investigated several peaks of the Executive Committee Range, Mt. Petras, USAS Escarpment, and the Clark Mountains. That same year he also observed the area on two reconnaissance flights (Doumani, 1964; Doumani and Ehlers, 1962a, 1962b). During the 1966–1967 field season the Byrd Land* survey party, sponsored by the National Science Foundation, included a total of eight geologists. One group was led by the writer, a second by Campbell Craddock, and cooperative investigations were conducted by a Soviet exchange scientist, L. V. Klimov. Some data from unpublished field reports are included in the map and this text.

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Bedrock and Superficial Deposits

The rocks of the Ford Ranges and Edward VII Peninsula exhibit striking similarities in composition and structure and are considered to belong to the same geologic province. The oldest rocks observed so far are gneisses, schists, and migmatites which comprise the range which includes the Fosdick Mountains and extends for a distance of about 100 km from Griffith Nunataks on the east to Mitchell Peak on the west. To the south of this unit of the Ford Ranges and to the west in Edward VII Peninsula is exposed a sequence of metasediments, mainly quartzites, graywackes, slates, and phyllites (Passel, 1945; Wade, 1937b). Structural evidence suggests that these rocks are younger than the more highly metamorphosed ones exposed in the Fosdick Mountains. Some of the beds of the sedimentary sequence have been metamorphosed to biotite schists near contacts with stocks and batholiths which intrude them. This undifferentiated sequence of dark, fine-grained, metasedimentary rocks has a minimum thickness of 4600 m (Warner, 1945). The cross-cutting plutonic rocks include granodiorite, granite, tonalite, adamellite, and leucoclase and sodaclase varieties of these rocks. Aplite is a late differentiate; pegmatites are quite common. All of these rocks are relatively rich in quartz.

No fossils have been found in the metasediments, and only their minimum age can be estimated. A schist from Breckinridge Peak, Rockefeller Mountains, has a radiometric age of 102±3 m.y. (see Table 1). Three specimens from plutons in the Rockefeller Mountains range in age from 92±5 m.y. to 104±4 m.y. Ages of an adamellite which intrudes the metasediments in the Clark Mountains, Ford Ranges, are 143±4 m.y. (K-Ar) and 137±9 m.y. (Rb-Sr) (Boudette *et al.*, 1966). The minimum age of the metasedimentary sequence must therefore be pre-Cretaceous.

East of the Ford Ranges, along the Ruppert Coast, the exposed rocks are principally mafic metavolcanics and felsic intrusives. In the metavolcanics there are a few fragmented inclusions of thinly bedded, gray, micaceous quartzites. Field evidence suggests that folding and metamorphism of the quartzites antedated the mafic magmatism and that the felsic intrusives may represent the most recent plutonic activity in the Byrd coast sector (Klimov, 1967). Between the Hull and DeVicq Glaciers on the Hobbs Coast there is a second area of gneiss outcrops. These gneisses are overlain by a series of volcanics consisting of laminated yellow-brown tuffs and highly vesicular basalts.

Inland from the Hobbs Coast there lie groups of peaks and ridges of volcanic origin. The largest of these, the Executive Committee Range, is comprised of a few minor ice-covered peaks and five major peaks, all of which have rock exposures. On Mt. Sidley four principal volcanic units are exposed. The oldest is a porphyritic, olivine andesite, which is succeeded in turn by a sequence of red tuffs, a light-yellow, porous tuff, and a firm, coarse, dark-gray to brown tuff. A radiometric age on the andesite is 6.2 m.y. (Pliocene). Field evidence suggests that the tuffs may be Pleistocene (Doumani, 1964).

Mt. Petras and the Flood Range consist of rhyolite flows and tuffs. The USAS Escarpment is composed of light-colored tuffs and tuff breccias on the eastern end and of basalt overlying granodiorite near the western end (Doumani, 1964).

Volcanics are present in the Fosdick Mountains, where a line of volcanic cones trending east–west along the axis of the mountains rests on the older metamorphic rocks. According to Fenner (1938), the principal extrusive material is olivine fourchite, which is quite similar to the Recent volcanic rocks of Ross Island, McMurdo Sound, and may therefore also be of Recent age.

Morainic debris, the most recent deposits, occurs on many of the gentle slopes and flat surfaces. Most of the fragments composing the till are derived from local rocks. Presumably, large morainic deposits are buried in the principal valleys and basins beneath the ice sheet and will not be exposed until deglaciation has taken place.

Structural Geology

Structural elements have been observed in some detail only in the western half of the map area, where structures in the gneisses, intrusives, and metasedimentary sequence all trend west–northwest. The metasedimentary sequence has been compressed into a closely folded anticlinorium with fold axes plunging gently in that same direction. Flow planes in the principal intrusives are parallel to the axial plane flow cleavage in the metasedimentary rocks. The Fosdick Mountains constitute an anomalous unit. They represent a remnant of the crestal portion of a broad open fold the axis of which passes through Mt. Iphigene and continues between Mt. Lockhart and Mt. Colombo. Limited gravity measurements suggest that these mountains are bounded on the north and south by faults. The less intense folding and the much higher degree of metamorphism of the rocks of these mountains as contrasted with the features of the metasedimentary rocks of the anticlinorium indicate different histories. The Fosdick and related mountains may be remnants of an elevated block of the basement complex.

A system of regional extension fractures trending N30°E transects both the metasedimentary and igneous rocks; some major wrench faulting has occurred along some of the fractures. Emplacement of the plutons appears to have been controlled by the structure of the metasedimentary rocks (Warner, 1945).

A regular alignment of each of two groups of volcanoes is evident. Those in the Fosdick Mountains lie along an east–west line, and four of the five peaks in the Executive Committee Range occur on a north–south line. Deep-seated fractures may be responsible for the regularities (Doumani, 1964). The geographic distribution of the older metavolcanics in the Hobbs Coast area suggests an east–west alignment of the vents of that period of activity.

Geologic History

The geologic history of Marie Byrd Land is poorly known. In the western half of the area the oldest sedimentary sequence, now represented by gneisses and migmatites of unknown age in the Fosdick Mountains, was deformed by folding and intensely metamorphosed. Later a geosyncline developed prior to the Cretaceous in which were deposited more than 4600 m of highly quartzose sediments. These beds were moderately to intensely folded along nearly east–west axes and intruded by a sequence of granite and granodiorite plutons in early to middle Cretaceous times. Adie (1964) has suggested that because of the close lithologic resemblances of the metasediments to those of the upper Paleozoic succession of the Antarctic Peninsula, they may represent a continuation of these Andean geosynclinal strata. If so, they are probably Carboniferous in age. Suspected block faulting at some unknown time probably resulted in the uplift of the Fosdick Mountains. During an extended period of erosion most of the metasedimentary formations were removed, and the igneous core of the orogenic belt was exposed. During or possibly before the Pliocene, volcanic activity commenced and probably continued sporadically through the Pleistocene. Some evidence suggests that volcanic eruptions have occurred since the advent of the present glacial stage.

Less is known about the geologic history of the eastern half of the area. The gneisses exposed between Hull and DeVicq Glaciers probably represent an ancient basement complex (Klimov, 1967). A period of volcanism followed the deformation of these old rocks, and a second interval of metamorphism reconstituted the volcanics as well as the older rocks. No sedimentary rocks which might represent an eastward continuation of those in the Ford Ranges have been observed, except for a small outcrop of quartzite on Shepard Island. Igneous activity, marked by the intrusion of felsic plutons in the area between Mt. Shirley and Mt. Gray, may have been contemporaneous with similar magmatism to the west. Volcanic eruptions in the Pliocene and Pleistocene were widespread throughout the area.

The mountains of Byrd Land owe their present configurations to the erosive action of glaciers. Field evidence indicates that all of the mountains investigated were once overridden by the ice sheet; this implies that the ice has been thicker than it is at present by 250 to 400 m.

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