Preliminary Geologic Report on the 1960 U.S. Expedition to Bellingshausen Sea, Antarctica

Abstract. Thurston Peninsula, although largely snow covered, exposes massive to foliated dioritic rock and schist exhibiting northeast-trending structures. One basalt pebble was found. The adjacent continental shelf is cut by submarine valleys. Peter I Island, a dissected basaltic volcano 250 miles to the northeast, was visited.

The first geologic data from part of the little-known 1500-mile coast between Alexander I Island and the Edsel Ford Ranges (Fig. 1) were gained between 16 and 24 February 1960 when the U.S. Navy ice breakers *Glacier* and *Burton Island* penetrated the Bellingshausen Sea adjacent to the north coast of Thurston Peninsula. Landings by helicopter and launch were made by us and by Philip M. Smith, National Science Foundation representative, at seven widely separated outcrops (inset, Fig. 1).

Thurston Peninsula is covered by an undulating ice cap characterized by deep embayments and domed surfaces, 1 to 5 miles across, near the central and eastern north coast. It is likely that much of the continuous ice cap near the north coast rests on several islands rather than a deeply embayed large peninsula. The layers of the Thurston Peninsula ice cap along the coast, and the layers of the ice caps of three groups of off-shore islets, are truncated by 5- to 100-foot cliffs. In deep embayments the ice cap surface slopes smoothly to level bay ice. Apron-like terraces of ice more than 100 feet thick surround the bases of several nunataks in the northeastern part of Thurston Peninsula. Running melt water was seen or heard at most localities visited. At one locality 14 thin ice and icy-snow layers were counted in a 7-foot snow pit dug in the ice cap.

Rock exposures constitute less than 0.1 percent of the peninsula area. Exposures are found on off-shore islets, at and near the bases of a few ice cliffs, and on a few glacial horns aligned along the major axis of the peninsula. Field identification showed that the bedrock at most localities is light to medium gray, massive to faintly foliated, medium-grained amphibole-bearing dioritic rock. Thick, distinct bands of schist, traceable for several hundred feet along the strike without noticeable change, are interlayered with gneiss in the easternmost part of the peninsula. The foliation of the rocks strikes northeast and dips steeply to the southeast. Most rock is unweathered, but some limonite stains are present. Mafic dikes up to 12 feet wide are present in many outcrops. Closely spaced joints, commonly in several sets, cut all exposed bedrock. Small faults with displacements of a few inches were seen in the eastern part of the peninsula. Disintegration has produced local talus and surface rubble. Silty soil that supports mosses has developed in places in the east. Lichens partly incrust most rock surfaces.

An anomalous basalt pebble, 1-inch long, was found among gneiss debris near the eastern end of Thurston Peninsula. This pebble is subrounded and slightly faceted, and part of the surface has a dull varnish. The closest known basalt is on Peter I Island, almost 250 miles northward. Basaltic bedrock on Thurston Peninsula is probable if the pebble is a glacial erratic. R. C. Murphy, the expedition ornithologist, suggested an alternative method of transport: the pebble may be an ejected stomach stone of a sea mammal, as described from California (*1*) and New Zealand (*2*).

Significant geologic data in the vicinity of Thurston Peninsula have been contributed from oceanographic work by J. Q. Tierney, R. M. Evans, and R. B. Starr of the U.S. Navy Hydrographic Office. Echo soundings show a smoothly rising continental slope sharply set off from a nearly flat continental shelf. The shelf edge is more than 200 fathoms deep, as is common in the antarctic (*3*). Echo soundings within 5 miles of the coastline reveal an irregular topography with relief of several hundred feet. The shelf appears to be cut by several submarine valleys that probably trend perpendicular to the coast. Local terraces on the shelf may be fault controlled. Coring and dredging near the shore yielded quartzose sand, black mud, and subangular fragments of felsic and intermediate plutonic and metamorphic rock which resembles rock collected ashore. One fine-grained quartzite fragment contains a ⅛-in. smooth, rounded depression, possibly the impression of a bivalve shell. Most fragments are encrusted with modern organic forms, primarily bryozoans and worm tubes. Fragments from one station also have a gray coating. The uncoated fragments may have been recently deposited by continuing transport of rocks by ice rafting.

The age and correlation of the rocks of Thurston Peninsula are unknown. The occurrence of plutonic and metamorphic rocks on the peninsula demonstrates that the region between the Edsel Ford Ranges and the Bellingshausen Sea is not entirely a volcanic rock province, as postulated by Bentley *et al.* (*4*) from geophysical data.

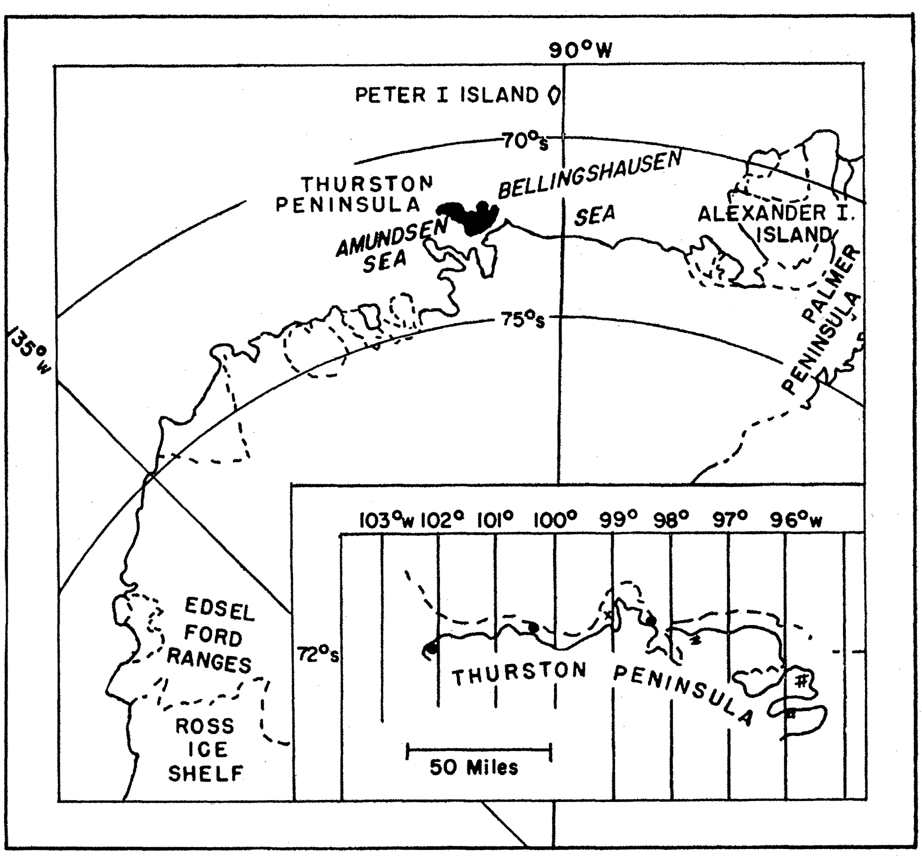

Fig. 1. Outline map of part of western Antarctica showing the location of Thurston Peninsula. The inset map shows localities visited by Craddock (#), Hubbard (•), and P. Smith (x). The dashed line shows the course of the U.S.S. *Glacier*.

Scientific work conducted at Peter I Island on 28 and 29 February and 1 March showed that the island covers less area and is higher (about 5700 feet rather than 4005 feet) than shown on U.S. Navy hydrographic chart HO-6630. Peter I Island is an extinct, deeply dissected volcano, almost entirely capped by ice; most rock is exposed on steep cliffs. At Norwegia Bay on the west side of Peter I Island, gray to dusky red, dense to vesicular basalt flows and bedded tuffs are cross-cut by basic dikes and a hypabyssal plug. The basaltic rocks contain olivine phenocrysts and mafic to intermediate inclusions (*5*).

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References and Notes

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4. C. R. Bentley, A. P. Crary, N. A. Ostenso, E. C. Thiel, *Science* **131**, 131 (1960).
5. Publication of this report was authorized by the director of the U.S. Geological Survey.

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Distinct "Feeding" and "Hunger Motivating" Systems in the Lateral Hypothalamus of the Rat

Abstract. Electrodes were implanted in the middle hypothalamus of rats to determine the neural organization of the "feeding" centers. Stimulations of the far- and midlateral hypothalamic area produced feeding responses in sated animals, but only the former caused sated animals to cross an electrified grill to press a lever for food. After lesions had been made in the medial forebrain bundle, however, stimulations in the far-lateral hypothalamic area resulted in feeding in sated animals but failure to cross the electrical barrier to press a lever for food. Simultaneous far-lateral and "satiety" center stimulations produced feeding in sated animals but failed to "motivate" grill-crossing behavior.

The middle hypothalamus functions to regulate food intake in several animal species and has been shown to be organized into a lateral "feeding" center and a medial "satiety" center (*1*). Anand and Dua (*2*) presented evidence that the lateral "feeding" center maintains constant facilitatory influences on feeding behavior and is held in check by the more medial "satiety" region, which presumably generates inhibitory impulses in response to monitoring some circulating material indicative of the satiated state. Previous evidence (*3*) shows that the medial forebrain bundle, for which the lateral hypothalamus serves as a bed nucleus, is not the critical lateral hypothalamic system controlling basic feeding behavior, since lesions in this bundle anterior or posterior to the level of the ventromedial nuclei do not alter feeding behavior in the rat. Aphagia and adipsia result only with lesions in this bundle at the ventromedial level. Morrison, Barrnett, and Mayer (*4*) have claimed that "the medial forebrain bundle itself may be as important as the lateral hypothalamus in the control of feeding behavior," but they failed to take into account that many other systems cross the lateral hypothalamus at the level of the ventromedial nuclei. Furthermore, the lesioning method in the complexly organized lateral hypothalamus cannot possibly dissociate the medial forebrain bundle fibers from the several other trajectories, mostly pallidofugal, which enter the hypothalamus at this level. The present experiments were undertaken to fractionate functional components comprising the "feeding" center so as to ascertain the relative importance of the several systems comprising the "center" and, more particularly, to determine the possible means by which an interplay occurs between the "feeding" and "satiety" areas.

Numerous studies on feeding behavior have used a single measurement—that is, the amount of food consumed—as a determinant of "appetite," whereas in reality the essential "hunger" drive is best determined by the effort an animal will go to in order to overcome a barrier to obtain food. That certain specific "motivational" systems exist in the lateral hypothalamic area of the rat has been shown by Olds (*5*), who has found that the more general motivating properties of hunger may be produced by electrical stimulation of specific points in the brain, especially along components of the medial forebrain bundle. Since our previous studies indicate nonessentiality of this bundle in basic feeding reactions, it may well be that the medial forebrain bundle is at least important in motivating barrier crossing to obtain food, that is, as a system concerned with "hunger." Thus an attempt to study this system and its relationships with the feeding facilitatory mechanisms lying in the far-lateral portion of the middle hypothalamus comprise a part of the present study.

Adult male and female albino rats were tested for several days in a Skinner box for lever-pressing activity for food under various conditions of starvation and satiation. After several days of training for several hours a day to establish baseline lever-pressing and feeding behavior, bipolar electrodes were stereotaxically implanted in the far-lateral hypothalamic area in four animals and in the midlateral hypothalamic area in three animals. Four additional animals were given bilateral lesions in the medial forebrain bundles; then, after a testing period, electrodes were implanted in the far-lateral hypothalamic area. Three other animals had electrodes implanted in the medial forebrain bundle anterior and posterior to the level of the "feeding" centers. Finally three animals had electrodes implanted simultaneously in the far-lateral hypothalamic area and "satiety" regions. Postoperatively, after readjustment to the testing box and lever-pressing routines were set up, continuous 10-minute stimulations were carried out 20 minutes apart for 3 hours (total of six 10-minute stimulations). The stimulus parameters used were square-wave pulses of 0.2-msec duration, 60 cy/sec, at 1 to 3 volts.

Electrical stimulation of the far-lateral hypothalamic area consistently resulted in high lever-pressing rates for food and voracious feeding in satiated animals as well as "motivation" to cross an electrified grill to lever-press and feed. Stimulations in the midlateral hypothalamic area, although they often produced feeding in satiated animals, never resulted in running of the electrified "barriers" to lever-press for food. Animals with lesions in the medial forebrain bundles anterior and posterior to the level of the "feeding" centers showed no disturbances in feeding behavior. They would not feed in the sated state and never ran the electrified grill. However, after these lesions, stimulations in the far-lateral hypothalamic area still produced feeding in sated animals but no "motivation" to cross the electrical barrier to lever-press for food. Stimulations in the medial forebrain bundle itself anterior or posterior to the level of the "feeding" centers resulted neither in feeding behavior or barrier-crossing in sated animals. Simultaneous stimulations in the far-lateral hypothalamic area and "satiety" centers resulted in feeding in sated animals but consistent failure to run the electrical barrier to lever-press for food.

These data seem to indicate that the medial forebrain bundle is important in the organization of the "feeding" center as a "hunger motivational" system, since overcoming "barriers" to get to food (a measure of "hunger") depends on the essential integrity of this bundle. With this bundle interrupted, no "hunger motivation" seems to be present in