RECONNAISSANCE SURVEY OF THE GEOLOGY OF THE SWAN ISLANDS, CARIBBEAN SEA

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This report has been prepared primarily to accompany the suite of hand specimens collected on these islands by personnel of the USC&GS Ship EXPLORER during the three days, March 12, 13, and 14, 1960. Some 89 samples have been turned over to the U. S. Geological Survey for further study. Samples were collected by Arthur D. Raff, Ronald K. Reed, Pedro A. Santiago, Michael Slapsys, and Harris B. Stewart, Jr. In the list of samples and on the sample location map that are part of this report, the collector of each specimen is identified by the first letter of his first name placed before the sample number (A-10, M-4, H-12, etc.).

The Swan Islands are a U. S. possession situated in the Caribbean Sea about 95 miles northeast of the coast of Honduras (Fig. 54). They consist of Great Swan Island, Little Swan Island, and a small limestone island awash in high seas called Booby Cay. The total area of the Swan Islands is less than 2 square miles. Great Swan Island is a little over 2 miles long and averages about half a mile in width. Little Swan Island is about 1½ miles long and averages about three-tenths of a mile in width. The islands have apparently been uplifted, and the coasts are characterized by

nearly vertical cliffs of reef limestone rising 50 to 60 feet above the sea. There is a good landing for small boats at the western end of Great Swan Island where a concrete pier, storage shed, and small hoist have been constructed. At this end of the island is the U.S. Weather Bureau station, a radio H-marker station operated by the Federal Aviation Agency for the navigational use of aircraft flying this part of the Caribbean, and the houses of the few Cayman Islanders and Hondurans who live on the island. Little Swan Island is uninhabited.

A small railroad track runs from the pier to the inner part of the island and once served to move the guano that was mined on the island to the pier for shipment. There is a small flat cart that is now pulled along the rails by a horse when materials have to be carried between the pier and the small settlement. There is no other transportation on the island.

The islands as they appeared prior to the 1955 hurricane are shown in Figure 51. Great Swan Island is in the foreground, with Booby Cay to the lower right. Little Swan Island is at the right in the background. The view is to the east.

Fresh water is in short supply on Great Swan Island, and none is available on Little Swan. There is a well near the center of the island; but the water is not always good although it is used to water the one horse and the few cattle now on the island. The main source of water is from catchment basins that trap rainwater falling

on the roofs of the buildings. The island is supplied about once a month by an interisland ship operated by the Hamilton Brothers Shipping Co., Tampa, Florida.

Little Swan Island is seldom visited, for the precipitous cliffs that surround it make small boat landings most hazardous. Landings can be made at only the few places where a slide has indented the cliffs, and provided a small platform at water level where personnel and equipment can be put ashore. Personnel from the EXPLORER were able to land on Little Swan Island about midway along the south shore by bringing a skiff in close to the base of a slide and transferring one person or one piece of gear each time the skiff rose high on a wave (Figs. 42 and 43.).

The complete report of the exploration of these islands including discussions of the offshore hydrography, the tides, currents, plants, insects, and reptiles is included in the cruise report of which the Swan Islands investigation was merely a part (Stewart, 1961).

During the 3 days devoted to the exploration of the islands and the collection of plant and animal specimens, 89 hand specimens of the rocks were collected, and outcrop descriptions and photographs were made at about 30 localities. Figure 53 shows the locations from which the hand specimens were collected.

The Swan Islands cap an isolated rise elongated in the east-west direction that is located on the south side of the Cayman Trough. The islands lie along what has been called the Swan Islands-Jamaica

South Haiti Fault Zone. To the west, the islands aline w th the Bay Islands off Honduras (Utilla, Ruatan, and Bonacca) where young Basalt flows are found, and farther west the trend is continued by the Sierra de Omoa of Honduras. Taber (1922) and Schuchert (1935) both advance the suggestion that the Swan Islands platform is a horst, an uplifted fault block. This may very possibly be the case for the entire platform, but the field examination of the islands themselves provided no evidence to confirm or deny this hypothesis.

Great Swan Island is characterized by a prominent upraised reef of coralline limestone forming cliffs 50 to 60 feet high along all but one small portion of the southern coast (Fig. 6). Along the northeast coast from the northern end of Jacobsons Bay west to Fowlers Point, the upraised reef is somewhat lower and is interrupted by occasional small bays with pocket beaches (Fig. 36). West of Fowlers Point, remnants of the reef can be seen in the low seacliffs (Fig. 37), but it appears to be missing along most of the north coast between Fowlers Point and the western end of the island. At the extreme west end of the island, for example, the seacliffs are made up of a massively bedded oolitic limestone (Fig. 38).

The upper surface of the upraised reef has in most places been eroded into very sharp and jagged short pinnacles that make walking almost impossible (Fig. 5). The seaward face of the reef is most precipitous, and there is evidence of notching of the seacliffs at the present sea level and perhaps slightly above (Fig. 40). Some of the large limestone blocks that have dropped from the cliffs show strong

evidence of this erosion related to the present sea level (Fig. 32).

The few beaches on Great Swan Island are made up primarily of coarse calcareous sand (Sample H-27). On the beach at Jacobsons Bay and to a less extent at Smith Bay beachrock has formed (Figs. 20 and 34, Samples H-8 and H-16). One small beach at the western end of the island just south of the boat landing was composed solely of rounded pieces of coral ranging up to 2 feet in diameter (Fig. 1 and 2). No other beach made of this material was found.

Throughout the flat vegetation-covered central portion of the island, the only outcrops found were in the former guano diggings in the northeast portion of the central flatland. Here guano and marl were the only rocks. Smith Bay on the south coast of the island was the only area where sedimentary rocks were exposed in any abundance. Here the limestone seacliff has been breached by the sea, and marine erosion has cut back into the relatively soft sediments behind the reef. Figure 22 is a view looking southwest along the shore of Smith Bay. The reef shows up as the irregular dark material at the far left, and the cliffed sediments can be seen to the right of it. Figure 8 is looking east across the mouth of Smith Bay where the reef has been breached. The limestone reefrock in the foreground is the western end of the breach, one portion of the eroded reef is exposed in the middle, and the reef continues at the far side of the bay. A portion of the sand beach of Smith Bay can be seen in the distance to the left of the upraised reef.

At the western end of Smith Bay, the contact between the reef material and the calcareous sediments behind it is abrupt. In Figure 11 the geology hammer rests on the contact, the reef rock is to the left, sediments to the right. The sediments making up the cliffs of Smith Bay are primarily fine grained calcareous mudstones. In some places the material is fine grained mudstone with thin laminar bedding (Fig. 14 and Sample H-5); at other places there is no evident bedding, and the material is coarser and contains rounded inclusions of the finer grained material and even blocks of the bedded material (Figs. 15 and 16 and Sample H-6).

The strike and dip of the beds exposed in the cliffs along Smith Bay vary through wide ranges over very short horizontal distances along the exposure. Most prominent were the steeply dipping beds (Fig. 17), and some dips approached the vertical (Fig. 19). Minor sedimentary structures included small folds and faults. Figure 21 shows a small fault running from the lower right to the upper left through the center of the picture. The pronounced drag folds suggest that relative motion along this fault was down on the right.

The southern coast of Little Swan Island is one continuous limestone cliff rising vertically 50 to 60 feet above the sea (Figs. 40 and 41). The northern coast rised equally steeply for 15 to 20 feet and then less steeply to the top of the island. Included

corals are common in the reef limestone forming these cliffs, and differential weathering has exposed these corals in many places along the top of the bluff (Figs. 46 and 47 and Sample H-30).

Little Swan Island, unlike Great Swan, has no sediments, but is composed entirely of upraised reefs. These reefs form a series of ridges that trend generally east-northeast to west-southwest (Fig. 52).

Only the three southernmost of these ridges were examined by personnel from the EXPLORER, for the solution holes, extremely sharp eroded reef limestone, dense vegetation between the ridges, and steep ridge faces made further penetration of the island most hazardous. A view from the top of the second ridge looking toward the south face of the third ridge is shown in Figure 50. From the aerial photographs (Fig. 52) and from conversation with the local Cayman Islanders, it was determined that the entire island was composed of the same type of reef ridges. Figure 33 is a view of the north side of Little Swan Island looking east from Jacobsons Bay on Great Swan Island. Below the low point on the skyline to the right of the middle of the view is the shallow channel separating Little Swan from Great Swan Island.

No outcrops of igneous rock were found on either island. However, along the west shore of Great Swan Island several pebbles and cobbles were collected that appeared to be a dark igneous material

shot through with veinlets of quartz. These rocks (Sample M-4) were in each instance well rounded, attesting to a long period of marine abrasion. Their source could not be determined in the field. The possibility of their having been derived from ballast from a sunken ship, or carried to the island by kelp-rafting or by marine mammals, was considered; but more probably they have been derived from an outcrop offshore. Although the magnetometer surveys around the islands have not yet been completely analyzed, field inspection of the records by A. D. Raff revealed one small anomaly off the northwest coast of Great Swan Island. This at least suggests that there might be a small intrusion of magnetic material into the otherwise calcareous material of the island platform, and that the igneous pebbles and cobbles might be related to the underwater outcrop of the intrusion.

The underwater geology of the reef along the north side of both islands was investigated by divers using Scuba equipment (Samples M-36, M-37, and M-38). These reefs are living, but the coral growth is considerably less abundant and less varied than on the luxurious reefs inspected off the Caribbean Coast of Panama. The major constituents of the Swan Islands reefs were a species of the large branched coral (Acropora), the smaller finger coral (Porites), the fan coral (Gorgonia), and the calcareous alga (Halimeda). Approaching these reefs from seaward, one first encounters a pebble pavement of rounded pieces of coral broken from the reef, then a narrow slpping band of extremely white rippled sand made up of finely comminuted grains of calcium carbonate, and

then the living reef with its abundant life. Underwater motion pictures of these reefs are included in the motion picture of the expedition.

Two boxes of labeled hand specimens of the rocks from Great Swan Island and one box of specimens from Little Swan Island were transmitted to the U.S. Geological Survey together with a copy of this report. Future discussions of the singularly interesting geology of these islands will have to await study of the hand specimens.

Attached to this report are 1) a list of the hand samples with pertinent information on location and outcrop description, 2) sample location map (Fig. 53), and 3) captioned photographs of geological features including some photographs of outcrops at which specimens were collected.

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References Cited

Schuchert, Charles, 1935, Historical Geology of the Antillean-Caribbean Region or the Lands Bordering the Gulf of Mexico and the Caribbean Sea, John Wiley & Sons, New York, 811 pp.

Stewart, Harris B. Jr., 1961, Oceanographic Cruise Report, USC&GS Ship EXPLORER - 1960, Government Printing Office, Washington, D.C., 162 pp.

Taber, Stephen, 1922, The Great Fault Troughs of the Antilles, Journal of Geology, Vol. 33, pp. 89-114.

Figure Captions

(Locations refer to Figure 53)

Fig. 1 Beach of rounded coral cobbles, Buffalo Point just south of landing dock. Location is just north of H-1 on sample location chart.

Fig. 2 Rounded coral cobbles on beach in Figure 1.

Fig. 3 View of Booby Cay taken from outer edge of upraised reef just east of location H-1.

Fig. 4 Vegitated crest of upraised reef. View is toward the northeast from a point about 100 yards east of location H-1.

Fig. 5 Closeup to show highly jagged and pitted erosion of the crest of the upraised reef. Location is about 100 yards east of location H-1.

Fig. 6 View to the east along the southern edge of the upraised reef bordering Great Swan Island.

Fig. 7 View to the east along the southern edge of the upraised reef. Location is at the tip of the promentory seen in the middle distance in Figure 6.

Fig. 8 View eastward across the mouth of Smith Bay. The remains of the eroded reef can be seen in the foreground and in the middle distance. Location is on point just south of H-2.

Fig. 9 East end of breached reef at the mouth of Smith Bay. View is to the southeast from a point on the shore of Smith Bay just east of location H-8.

Fig. 10 View toward the north along the cliffs forming the west shore of Smith Bay. Note the eroded crest of the upraised reef in the foreground. Sediments are exposed in seacliffs behind the reef. Location is H-2.

Fig. 11 Geology pick is on the contact between the upraised reef (left) and the back-reef sediments (right) at western side of the entrance to Smith Bay. Location is H-3.

Fig. 12 Talus slope below contact shown in Figure 11. Sediments are at upper right, reef at upper left. Location is midway between H-3 and H-4.

Fig. 13 Lower face of seacliff immediately below area shown in Figure 12. Location is H-4.

Fig. 14 Thin bedded mudstone along the base of the seacliff on the west side of Smith Bay. Beds dip 40° toward 265°m. These beds apear to underlie the cliffs along most of Smith Bay and extend from the waterline to heights of four to five feet above it. Location is H-5. See also Figure 18.

Fig. 15 Claystone concretion (Sample H-6) included in lighter colored mudstone along seacliff at Smith Bay. Location is H-6.

Fig. 16 Large blocks of finely bedded mudstone included in massively bedded lighter colored mudstone. Location is between H-6 and H-7 on shore of Smith Bay.

Fig. 17 Steeply dipping beds of mudstone (?) between H-6 and H-7 along Smith Bay.

Fig. 18 Dark material at left of lower center is believed to be the same material as shown in Figure 14. Just above it and slightly to the right is beachrock now some four feet above the waterline. Confused bedding pattern above is in mudstones. Location is just west of H-7.

Fig. 19 Nearly vertical beds. Location is a few yards east of H-7.

Fig. 20 Beachrock just at the high water line of Smith Bay. Location is H-8 (Samples H-8a and H-8b came from this slab).

Fig. 21 Small fault with drag folds in sea cliff on north shore of Smith Bay. Location is H-7.

Fig. 22- Seacliffs along west side of Smith Bay. View is toward the southwest from near Location H-8. The western

end of the breached reef (Location H-2) shows at the extreme left.

Fig. 23 Iguana trail left in the beach sand of Smith Bay.

Fig. 24 View from seaward of offshore rock midway between Smith Bay and Jim Duff Hole.

Fig. 25 Flat central portion of Great Swa Island. Plams were destroyed by hurricane. Location is near H-13.

Fig. 26 Contact between flat central portion of Great Swan Island and the inland side of the upraised reef. View is south toward the upraised reef and the sea from a point about 100 yards in from the sea about midway between Buffalo Point and Smith Bay.

Fig. 27 View from seaward of the upraised reefs forming the south side of Great Swan Island. Location is east of Jim Duff Hole.

Fig. 28 Steep face of upraised reef at the extreme end of Great Swan Island looking east across the narrow channel to Little Swan Island. Location is H-25.

Fig. 29 Upraised reefs and dense underbrush at extreme eastern end of Great Swan Island. Location is near H-25.

Fig. 30 Massively bedded and highly jointed mudstone exposed over a small area at eastern end of Jacobsons Bay. Location is H-22.

Fig. 31 Undercut reef at east end of Great Swan Island between locations H-23 and H-25.

Fig. 32 Highly undercut block that had tumbled from the reef above. Eastern end of Great Swan Island near location H-23.

Fig. 33 View from high ground above Jacobsons Bay (near Location H-19) looking eastward toward the north shore of Little Swan Island. Below the low point on the skyline to the right of center is the channel between the two islands.

Fig. 34 Beachrock along the shore of Jacobsons Bay. Location is H-16.

Fig. 35 Northwest end of Jacobsons Bay. The sea is to the right. Location is near H-18.

Fig. 36 Small pocket beach near Fowlers Point.

Fig. 37 Remnant of the low reef on the north side of Great Swan Island, west of Fowlers Point.

Fig. 38 Beds of oölitic limestone exposed in low seacliffs at west end of Great Swan Island. Location is H-11.

Fig. 39 Indurated mudstones with one-inch bedding dipping 85° toward 050° m. Location is H-10.

Fig. 40 Seacliff forming the rugged south coast of Little Swan Island. View is toward the east near location H-28. Note apparent notching at sea level.

Fig. 41 View from seaward of the vertical cliffs along the south coast of Little Swan Island.

Fig. 42 and Fig. 43 Landing on the south coast of Little Swan Island. Location is near H-29.

Fig. 44 South coast of Little Swan Island.

Fig. 45 Deep crevasse in the upraised reef on Little Swan Island. Location is near H-31.

Fig. 46 Porites included as part of the upraised reef. Location is H-30. (Photograph by B. Hale).

Fig. 47 Coral included in upraised reef. Present altitude is estimated at 60 feet above sea level (Photograph by B. Hale).

Fig. 48 Typical surface of the upraised reef on Little Swan Island.

Fig. 49 Cactus on Little Swan Island.

Fig. 50 View from the crest of the second reef inland from the south side of Little Swan Island looking north at the third and higher reef. Sample H-34 is at the base of this third reef, H-35 at the crest. Note deep solution hole in foreground.

Fig. 51 Aerial photograph of the Swan Islands flown prior to 1955 hurricane. View is toward the east. Great Swan Island is in the foreground, Booby Cay at the lower right, and Little Swan Island in the right background. (U.S. Navy photograph).

Fig. 52 Composite aerial photograph of the Swan Islands flown by the U.S. Air Force in November 1959 at the request of the U.S. Coast and Geodetic Survey. Note especially the pronounced ridges on Little Swan Island.

Fig. 53 Rock sample location map, Swan Islands. Map is shoreline manuscript prepared by USC&GS from the photographs flown by the U.S. Air Force and shown in Figure 52.

Fig. 54 Track chart of the EXPLORER Expedition showing the location of the Swan Islands.

ROCK SAMPLES, SWAN ISLANDS

(See Figure 53 for Locations)

GREAT SWAN ISLAND

H-1 Specimen of heavily eroded reef-forming limestone. Southwest end of Buffalo Point. See Figure 5.

H-2 West end of Smith Bay. Crest of reef near contact with mudstone. See Figure 10.

H-3 Dense limestone from 4 feet, below the top of cliff forming west end of Smith Bay. Sample just below and north of Sample H-2. This is at the contact with the mudstone (H-4).

H-4 Mudstone found at the water line from outcrop extending to 4 ft. above the water line, massively bedded with joint cracks, and approximately 20 ft. below the highly jointed mudstone in contact with the upraised reef (Sample H-3). Location is west shore of Smith Bay at the base of the cliffs. See Figure 13.

H-5 Thin-bedded mudstone along base of cliff. West shore Smith Bay. Beds dipped 40° toward 265° m. This appears to underlie the cliffs along most of Smith Bay. From right at water line to from 4 to 5 ft. above it. See Figure 14.

H-6 Claystone concretion included in lighter colored clay (See Sample H-7). From cliffs along north shore of Smith Bay. See Figure 15.

H-7 Highly fractured (along bedding planes) mudstone 10 ft. above water line north shore cliffs of Smith Bay. Sample from right hand side of fault shown in Figure 21.

H-8a Beach rock north shore of Smith Bay; broken from slab about 6 ft. across and 4" thick. Note small quartz pebble circled on the sample (source ?). See Figure 20.

H-8b Same location as H-8a but from opposite end of the same slab. Mudstone inclusions probably from outcrop of same material as sample H-4. See Figure 20.

H-9 Limestone (mudstone ?) from very hard outcrop on first point north of landing beach. Many rounded and large blocks of coral on the surface nearby. (Niggerheads brought up by the surf ?).

H-10 Indurated mudstone with one inch bedding - dipping 85° toward 050° m. Location is just east of north end of first point north of landing beach. See Figure 39.

H-11 Oolitic limestone from flat lying beds only a few tens of yards northeast of H-10. Sample from close to top of 15-18 ft. cliff. No reef seaward of it. Undercutting by waves has caused great blocks to break off and fall to beach. See Figure 38.

H-12 Thinly bedded mudstone 50 yards north of H-11, east of first point north of boat landing. Beds dipped 60° toward 060° m.

H-13 Oolitic limestone from middle of island, midway between Smith Bay and Folwers Point. Sample recovered from roots of up-turned palm tree.

H-14 Guano (?) from shallow pit near middle of the island where guano was removed about one hundred years ago.

H-15 Piece of coral from upraised reef above beach at Jacobsons Bay.

H-16 Beach rock from north end of Jacobsons Beach just below water line. (See Figure 34).

H-17- Piece of reef at north end of Jacobsons Bay where reef meets the beach. See Figure 35.

H-18 Very dense limestone (?) picked up as a cobble at the north end of Jacobsons Bay.

H-19 Thin bedded mudstone not in place but this chunk removed from soil 8 feet below the surface inside old treasure diggings at Jacobsons Bay.

H-20 Brick (?) found along berm line on Jacobsons Beach.

H-21 Chunk of broken blocks along beach. Blocks had been dropped from upraised reef some 50 feet above.

H-22 Mudstone above blocks broken from reef east end of Jacobsons Bay. No obvious or uniform bedding. Many separate blocks. This sample appeared to be from outcrop.

H-22 (continued) See Figure 30.

H-23 From outcrop of bedded mudstone two feet above water line and below sample H-22 east end of Jacobsons Bay.

H-24 From strike ridge of indurated mudstone crossing trail west of Jacobsons Bay. Beds dip 15° toward 250° m.

H-25 Piece of reef material from upraised reef at estimated 40 feet above water at extreme eastern end, Great Swan Island. See Figure 28.

H-26 Beach rock at Jacobsons Bay 100 yards northwest of trail end. Rock was exposed at low tide only. Shoreward edge exposed at high tide.

H-27 Beach sand from shore of Jacobsons Bay at end of trail. Sand retained in small conch shells with opening stuffed with sea lettuce.

H-37 Piece of reef from 12 feet of water west side of Fowlers Bay obtained by diving.

H-38 Piece of rock from 25 feet deep north side Great Swan Island west of Fowlers Point. Obtained by diving.

H-0 Locally called "floating rock" picked up at Jacobsons Beach east end of Great Swan Island. When dead and dry it does float. (No chart location or specimen number).

Samples A-1 through A-11 (including two A-6½) have no outcrop information.

R-1 (2 Samples) Coral sample found on southeast side of island.

R-2 On east central side of island.

R-3 East central side of island.

R-4 From northeast end of island.

R-5 From northeast side of island.

R-6 On beach northeast side of island.

R-7 From beach on northeast side of island.

R-8 Southeast side of Great Swan Island.

R-9 Southeast side of island opposite offshore rock.

R-10 Coral sample found on beach on southeast side of island.

R-11 From position on south coast opposite offshore rock.

R-12 Coral sample from beach southeast side, Great Swan Island.

R-13 Coral sample southeast side Great Swan Island.

R-14 Coral sample from southeast side of island.

R-15 Coral sample southeast side Great Swan Island.

P-1 Sample broken from larger specimen one-half mile northwest of landing beach.

P-2 Northwest side of island about 100 yards from the beach.

P-3 From a cliff about 10 feet high at the beach on northwest side of island. This was the only rock of this type found in this area.

P-4 Sample from about 12 yards east of swamp near main radio tower.

P-5 From larger rock at the beach between James Point and Fowlers Point.

P-6 Northwest side of island from rock about 3 times this size at James Point.

P-7 Three pieces from the beach between Northwest Point and James Point.

M-1 Shell found on the trail 1000 feet northeast of Fowlers Point.

M-2 Sample broken from large block 1000 feet east of Fowlers Bay.

M-3 Sample cut from larger block.

M-4 Igneous pebbles picked up on beach at west end of Great Swan Island. (Source ?)

LITTLE SWAN ISLAND

H-28 Piece from crest of upraised reef along south coast estimated 60 feet above water. (See Fig. 40)

H-29 Reef coral from crest 500 yards west of H-28.

H-30 Porites chipped from area approximately 10 feet square where cemented Porites formed a pavement. (See Fig. 46)

H-31 Reef material from crest of upraised reef along south coast. (See Fig. 45)

H-32 Sample from crest of upraised reef 100 yards west of H-31.

H-33 Secondary deposition (calcite?) not found *in situ* but as float on reef about 50 feet above the water. None seen in place.

H-34 Sample from base of third reef inland from south coast. (See Fig. 50)

H-35 Sample from crest of third reef inland from south coast. (See Fig. 50)

H-36 Piece of reef rock broken from upraised reef 15 feet below sea level, recovered by diving along outer edge of reef north side of island.

M-1 From crest of upraised reef along south shore. Note especially attached rock and separate piece of similar material. (Possibly secondary deposition.)

M-2 Unidentified piece of material found on crest of upraised reef along south coast.

R-1 Sample chipped from face of cliff about 75 feet inland from the sea cliff, south coast.

R-2 Sample from crest of upraised reef southwest end of island.

R-3 Piece of eroded upraised reef, southwest end of island.

R-4 Sample of upraised reef, southwest end of island.

R-5 Sample from upraised reef about 200 feet west of extreme eastern end of island.

Note Samples A, B, and C were obtained by a party erecting hydrographic survey signals at east and northeast ends of island.

A Samples of modern coral thrown at least 60 feet high onto the ancient upraised reef and sample of comparable coral (same species?) chipped from the upraised reef.

B Sample from crest of upraised reef easternmost tip of island.

C Sample chipped from crest of upraised reef, extreme eastern end of island.

TABULATION OF USC&GS FILE NUMBERS OF PHOTOGRAPHS USED IN REPORT OF SWAN ISLANDS GEOLOGY

Figure	File Number
1	IS-21891-C
2	IS-21891-B
3	IS-21891-D
4	IS-21891-E
5	IS-21891-F
6	IS-21891-G
7	IS-21890-A
8	IS-21890-D
9	IS-21890-R
10	IS-21890-C
11	IS-21890-E
12	IS-21890-G
13	IS-21890-F
14	IS-21890-H
15	IS-21890-I
16	IS-21890-J
17	IS-21890-K
18	IS-21890-L
19	IS-21890-M
20	IS-21890-P
21	IS-21890-N - 21890-O
22	IS-21890-Q

Figure	File Number
23	IS-21890-S
24	IS-21891-I
25	IS-21890-T
26	IS-21890-B
27	IS-21892-E
28	IS-21892-B
29	IS-21892-A
30	IS-21891-H
31	IS-21891-L
32	IS-21891-J
33-	IS-21891-A - IS-21891-N
34	IS-21892-C
35	IS-21891-K
36	IS-21890-Y
37	IS-21890-X
38	IS-21890-W
39	IS-21890-V
40	IS-21738-H
41	IS-21892-F
42	IS-21892-G
43	IS-21892-N
44	IS-21892-Q
45	IS-21892-M
46	IS-21740-E
47	IS-21740-F

Figure	File Number
48	IS-21892-W
49	IS-21892-R
50	IS-21892-O
51	No number assigned
52	No number assigned
53	No number assigned
54	HEA-21881

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

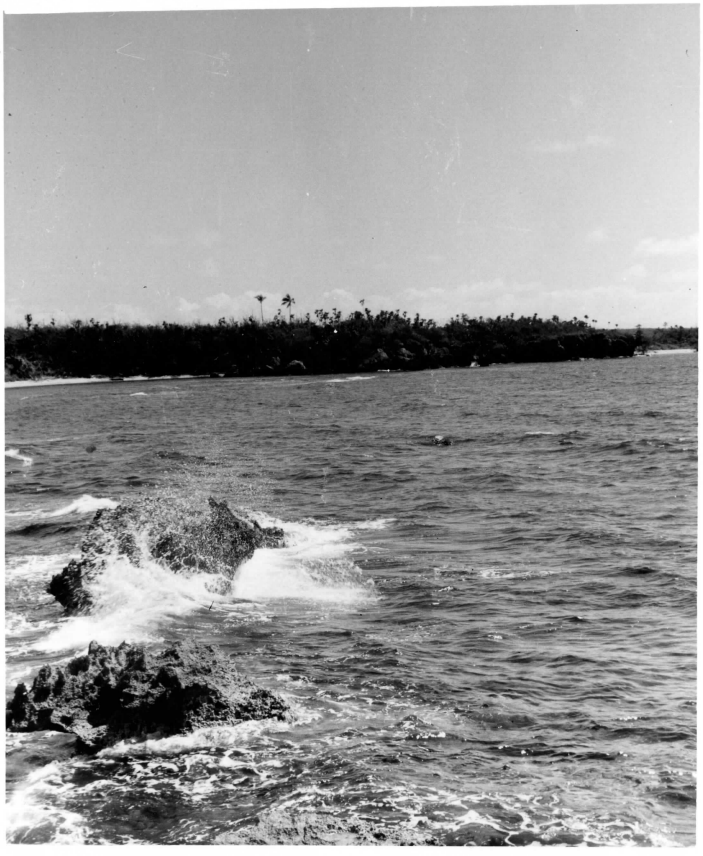


Fig. 8

Fig. 9

Fig. 10

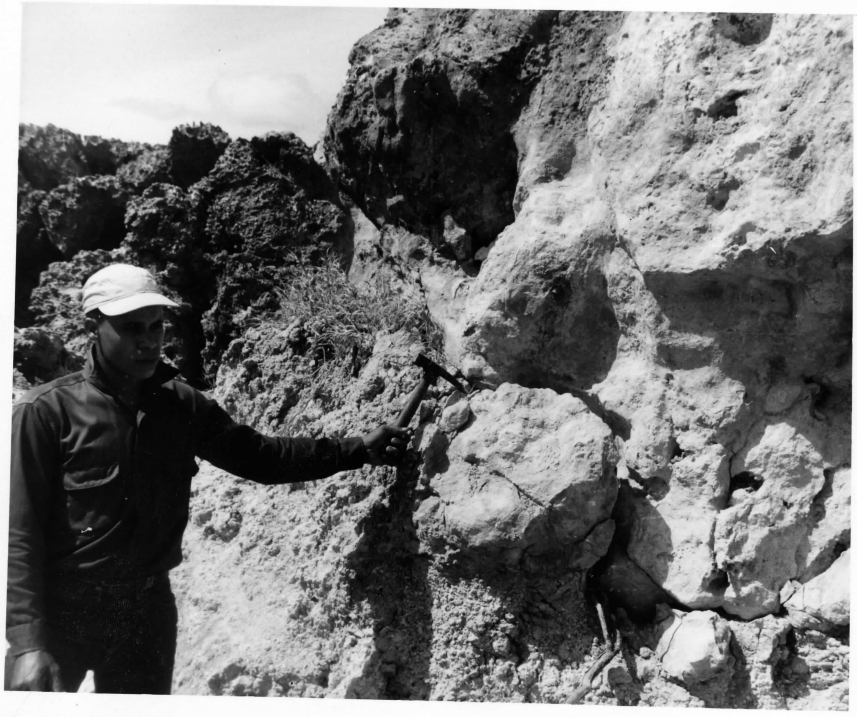


Fig. 11

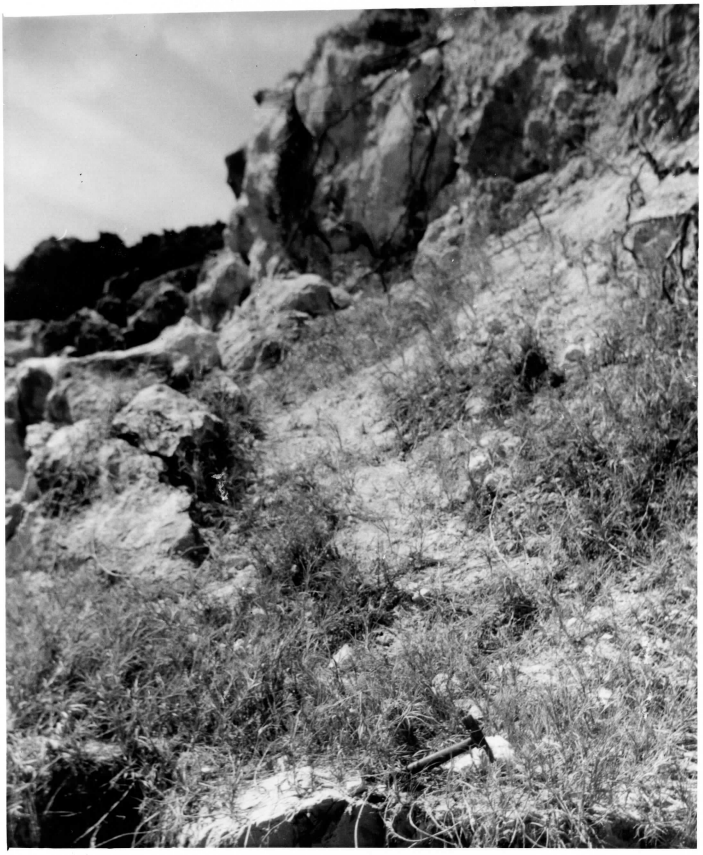


Fig. 12

Fig. 13

Fig. 14

Fig. 15

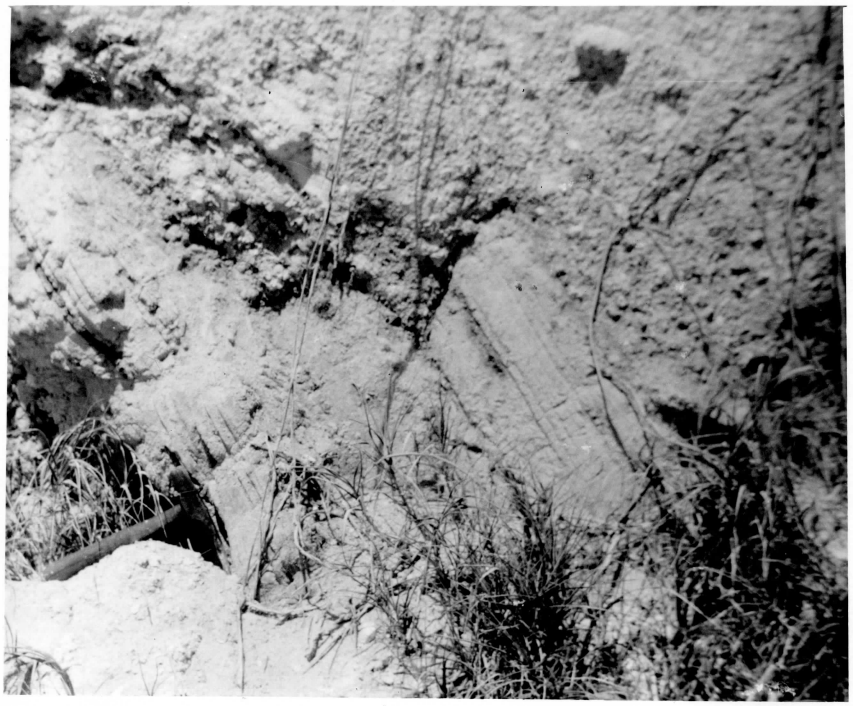


Fig. 16

Fig. 17

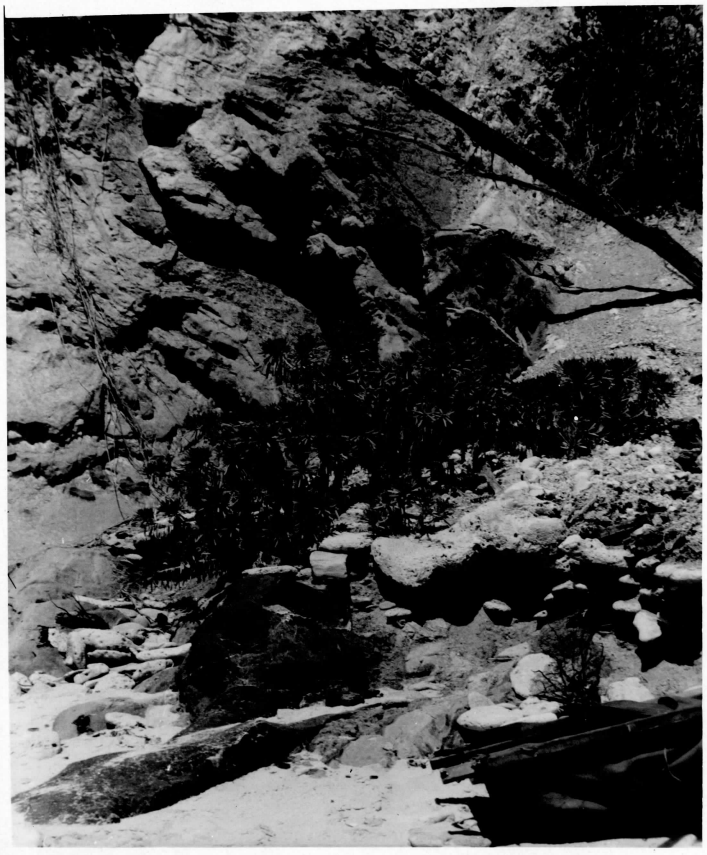


Fig. 18

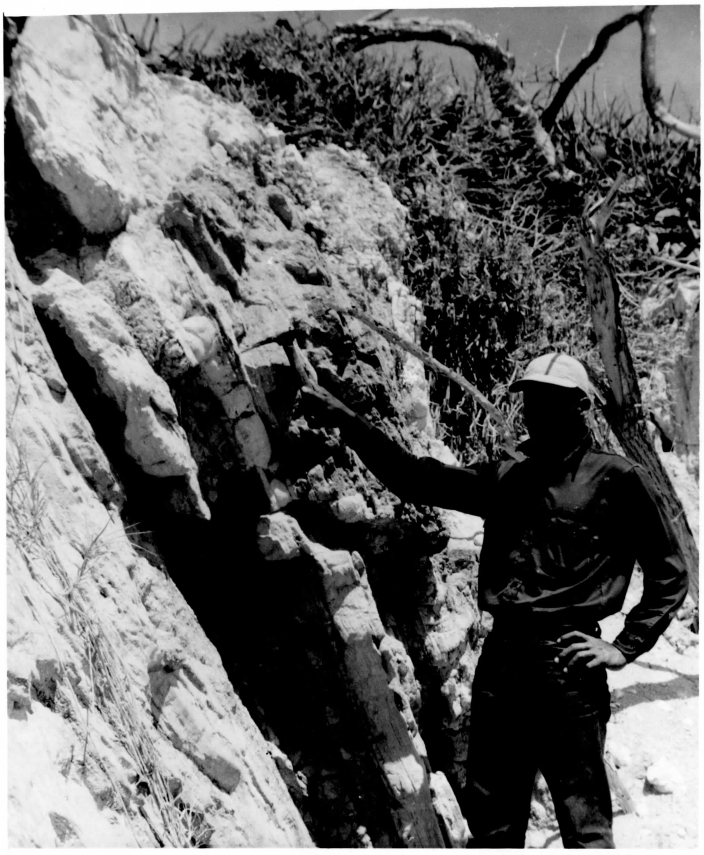


Fig. 19

Fig. 20

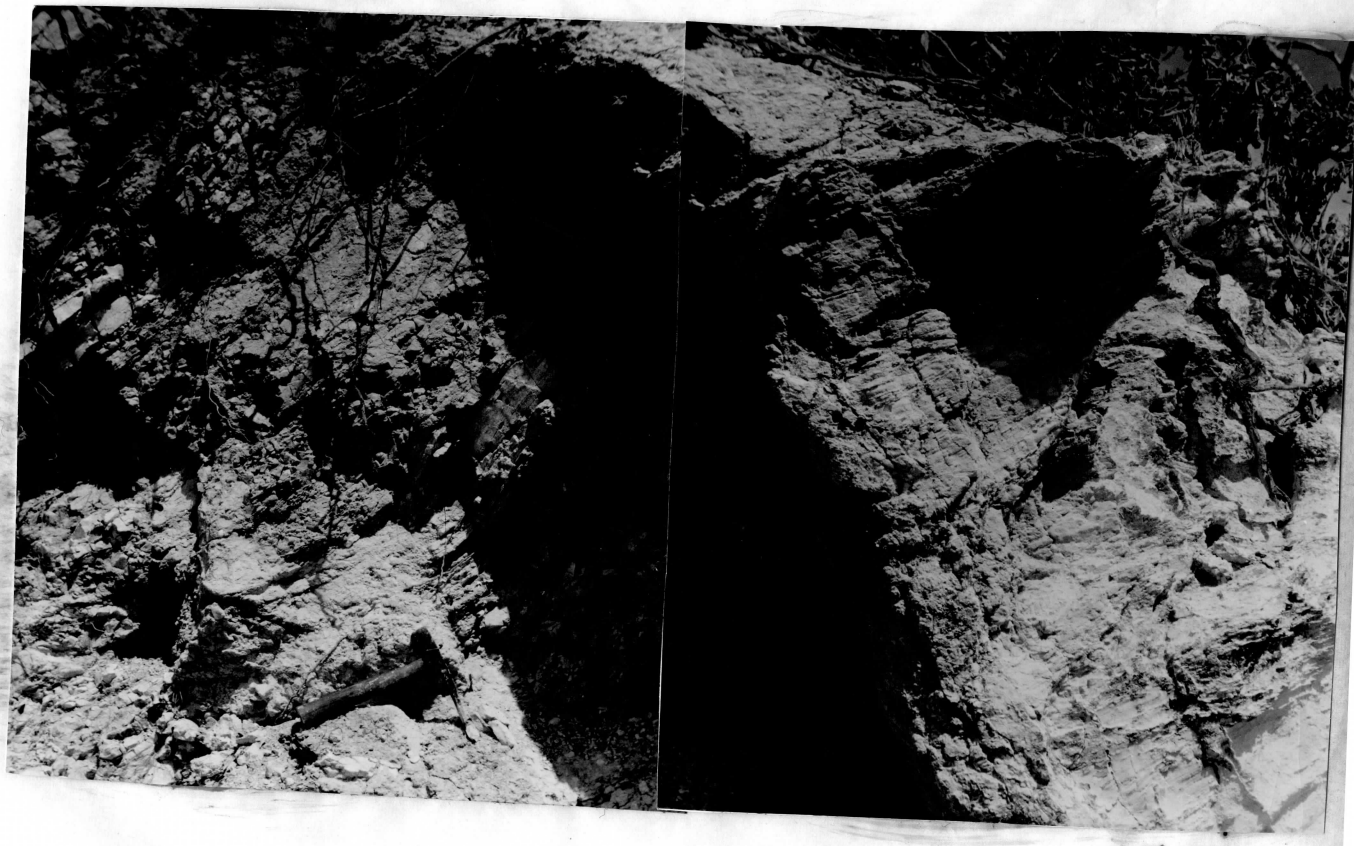


Fig. 21

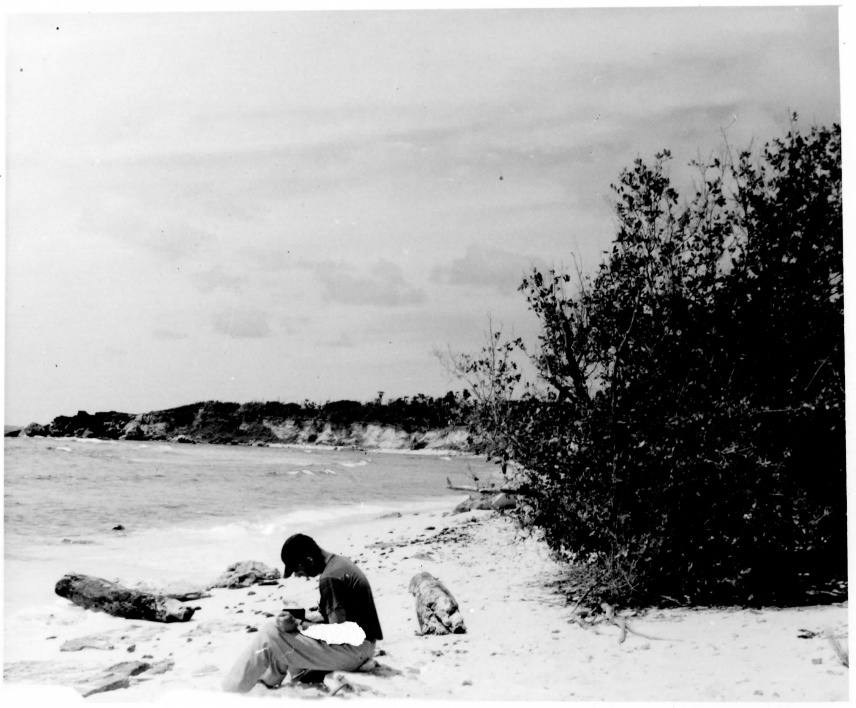


Fig. 22

Fig. 23

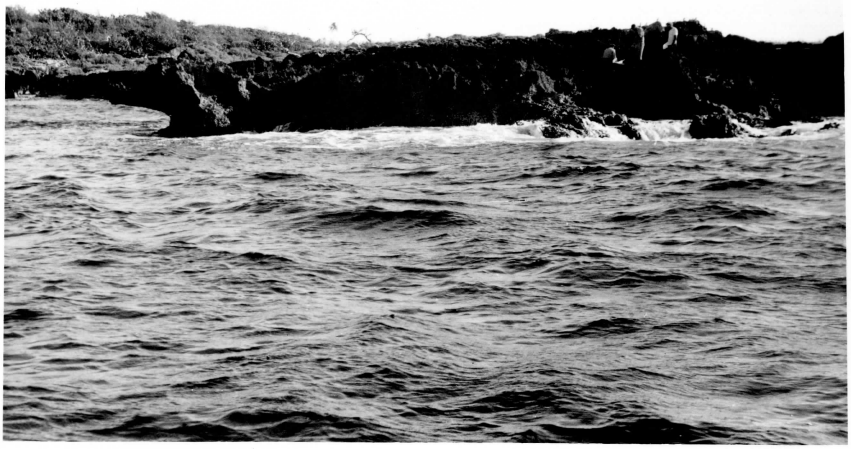


Fig. 24

Fig. 25

Fig. 26

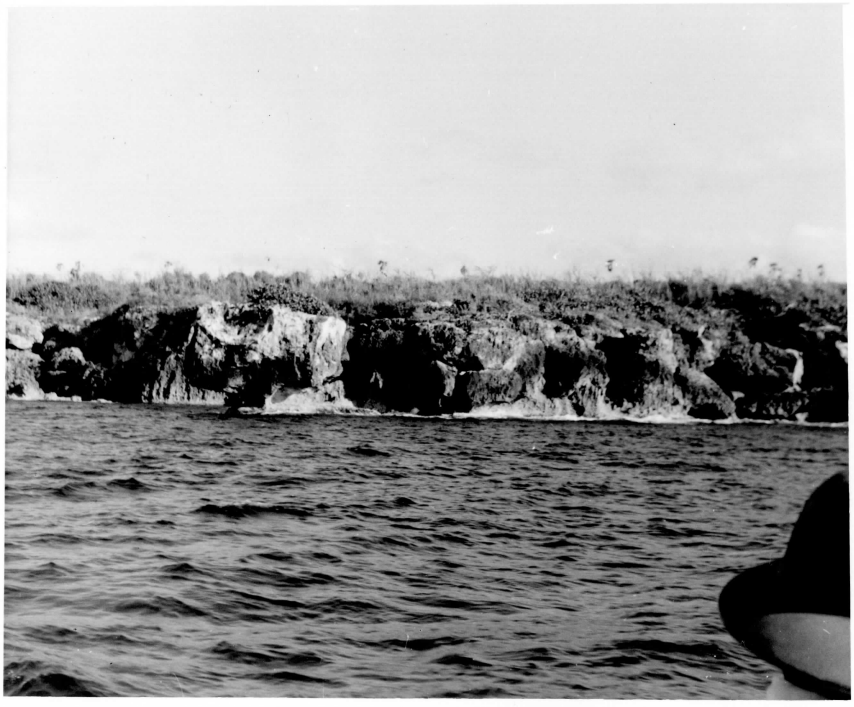


Fig. 27

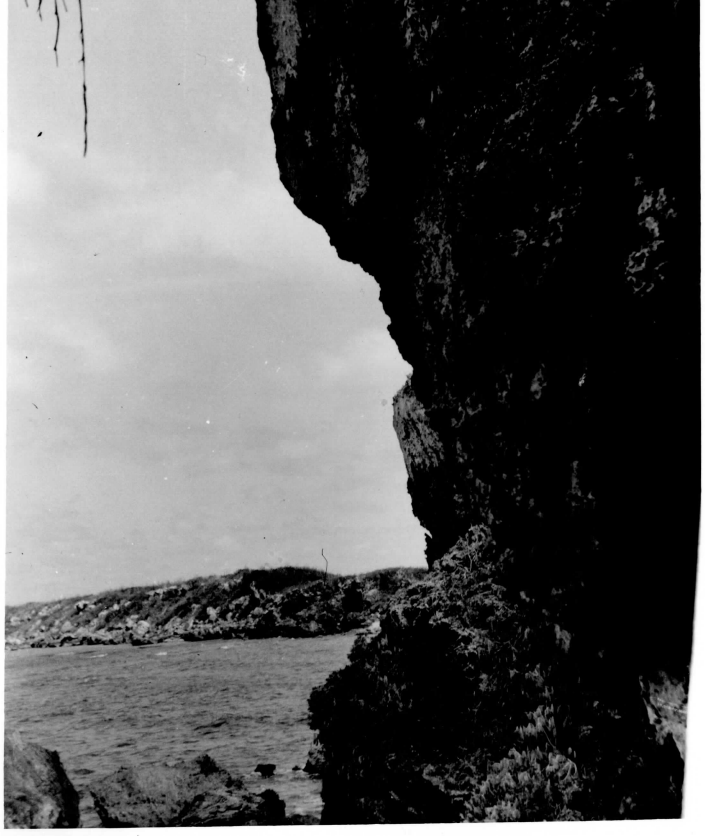


Fig. 28

Fig. 29

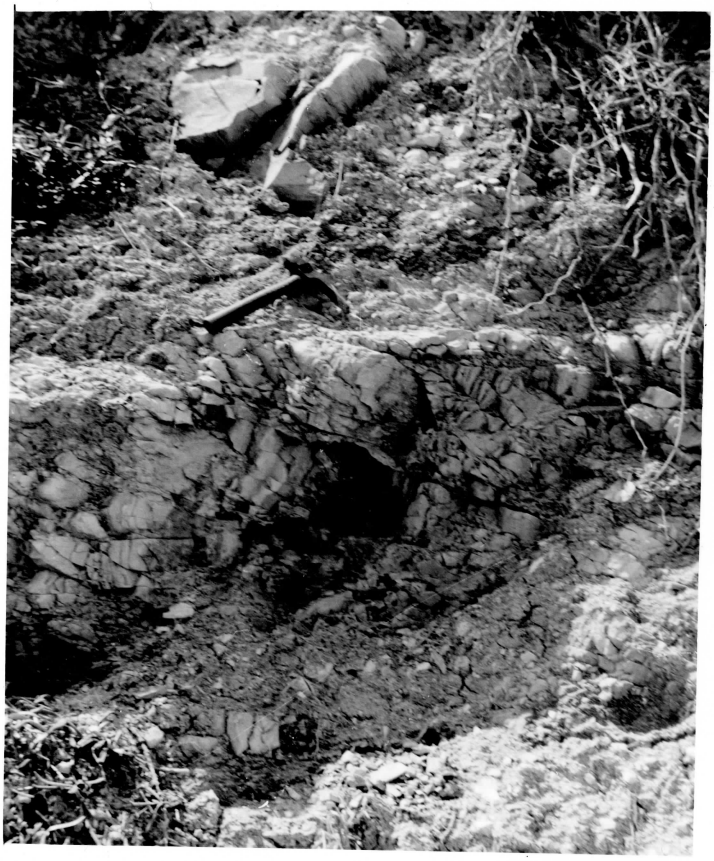


Fig. 30

Fig. 31

Fig. 32

Fig. 33

Fig. 34

Fig. 35

Fig. 36

Fig. 37

Fig. 38

Fig. 39

Fig. 40

Fig. 41

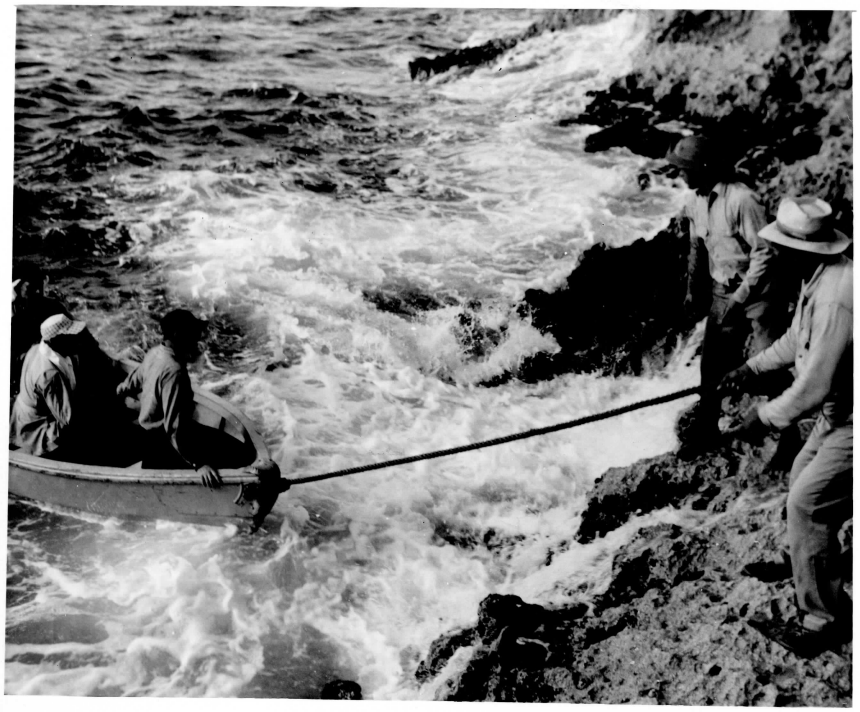


Fig. 42

Fig. 43

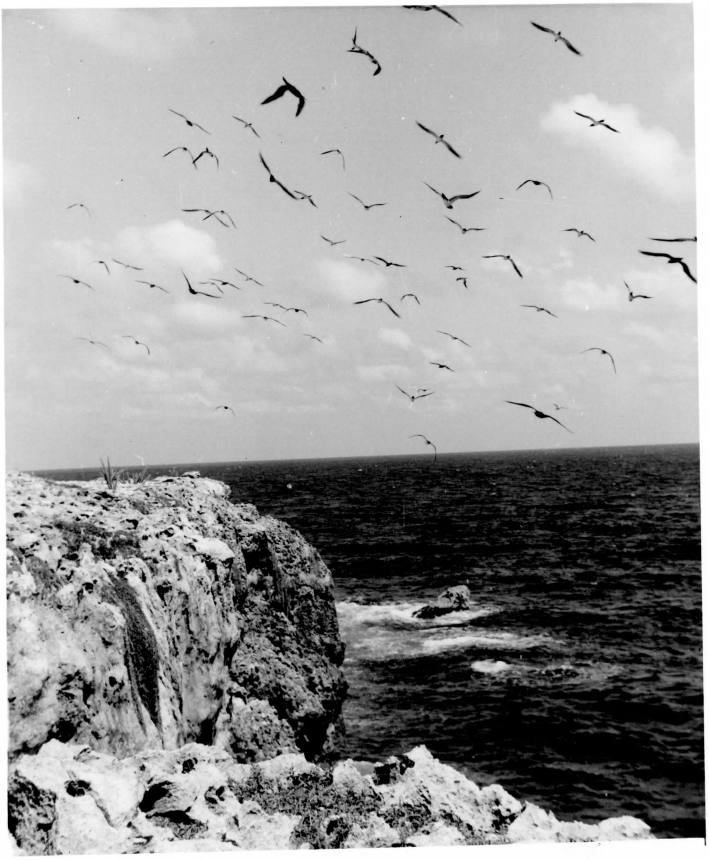


Fig. 44

Fig. 45

Fig. 46

Fig. 47

Fig. 48

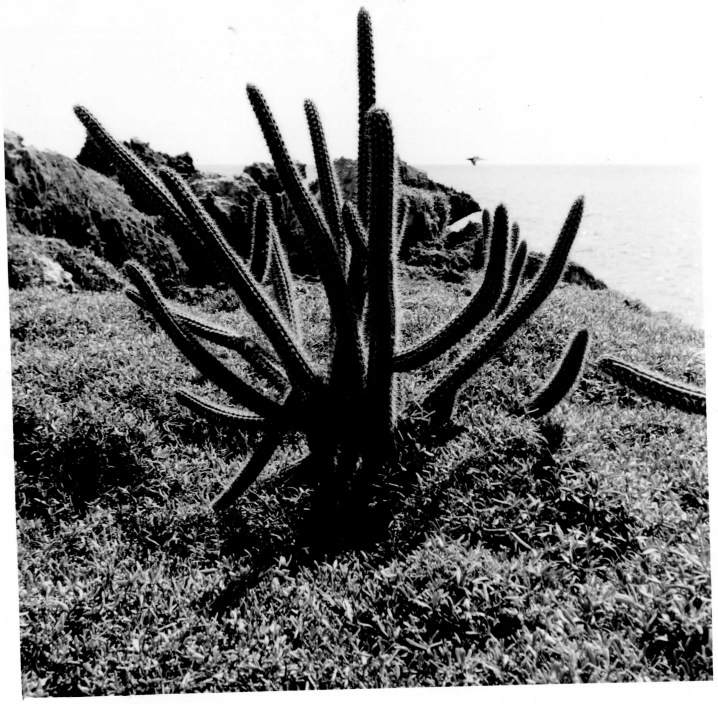


Fig. 49

Fig. 50

Fig. 52

APPROX.
NORTH

FOWLERS
POINT

FOWLERS
BAY

JAMES
PT.

NORTHWEST
POINT

BUFFALO
POINT

BOOBY
POINT

BOOBY
CAY

GREAT SWAN ISLAND

SMITH
BAY

JIM DUFF
HOLE

JACOBSONS
BAY

H38 H37 P6 P5 P7 P2 M3 P3 H13 P1 P4 H12 H11 H10 H9 M4 H8 H7 H6 H5 H4 H3 H2 H1

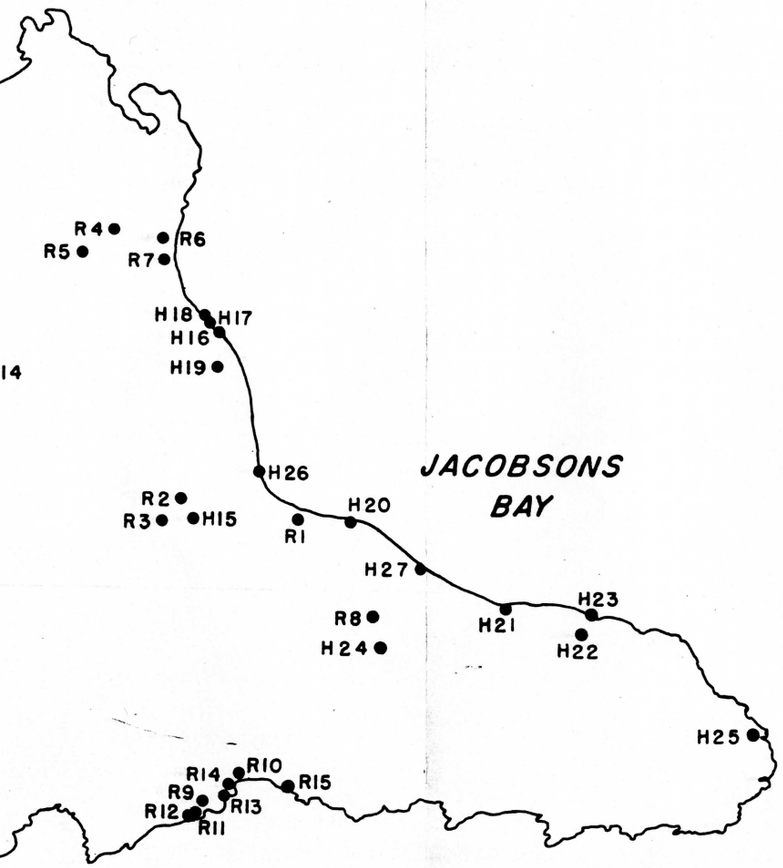
A11 R4 R5 R6 R7 A10 A9 H18 H17 H16 M2 A8 H14 H19 A7 A6 A5 M1 H26 R2 R3 H15 R1 H20 H27 R8 H24 H23 H21 H22 H25

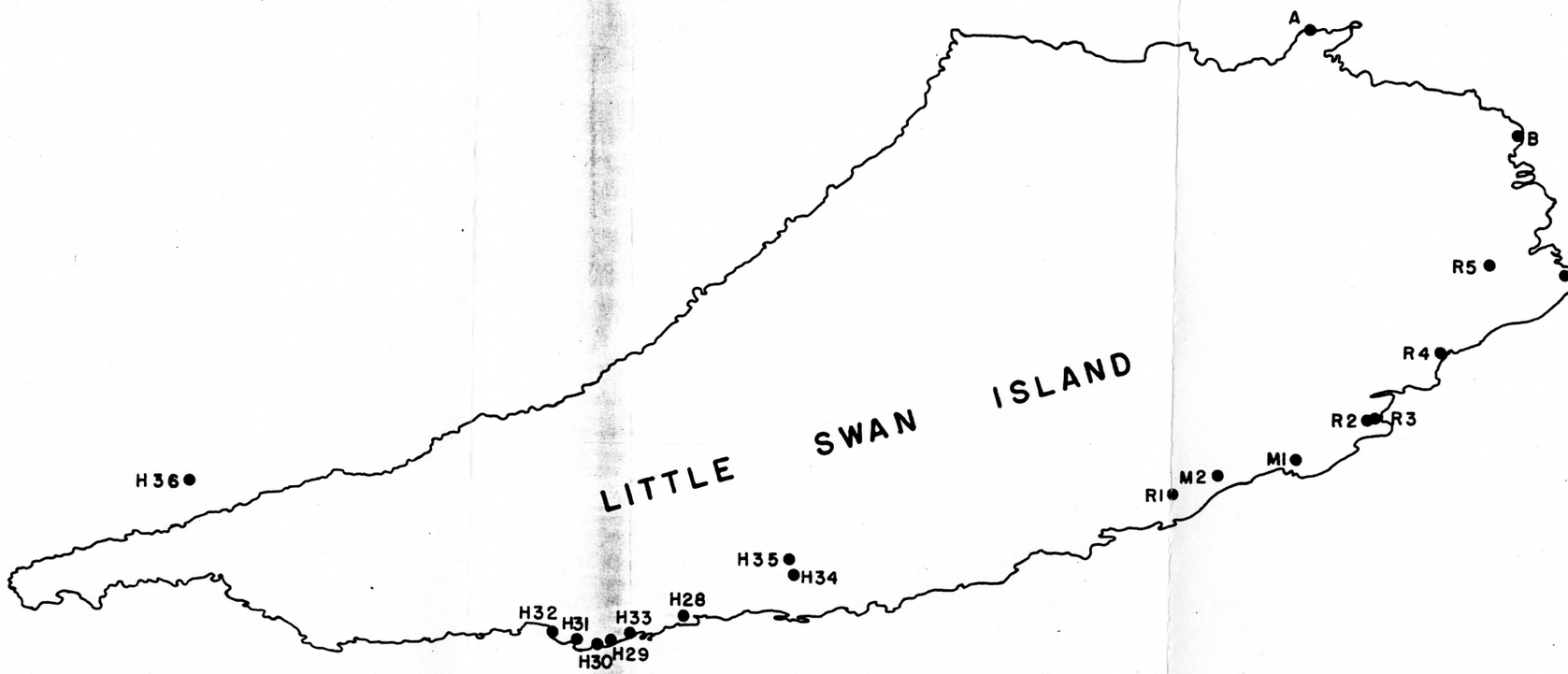
A1 A2 A3 A4 R14 R10 R15 R9 R13 R12 R11

Swan Islands

Location of sites from
which geological samples
were recovered 12-14 March, 1960

U.S. C





1960

U.S. Coast & Geodetic Survey

Fig. 53


Seattle
UNITED STATES
Washington
Norfolk
San Diego
DROWNED BARRIER
SPIT AND LAGOON
MEXICO
Key West
Is Revilla Gigedo
Swan I.
Clipperton I
Cristobal
Panama

Fig. 54