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A continuous seismic survey of the Bermuda Platform, Part I: Castle Harbour*

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Introduction

The Bermuda Islands are situated in the western North Atlantic at approximately 32°20'N and 64°45'W. The closest point of land is Cape Hatteras 580 nautical miles towards the west. The entire NE-SW trending island-complex is about 20 miles long and up to two miles wide. The Bermuda archipelago is composed of an estimated 365 islands, which are scattered over the summit of a volcanic seamount, which has an areal extent of 250 sq. miles and is known as the Bermuda platform.

The volcanics of the Bermuda platform, which were recently dated by the K:Ar method (Gees 1969), yielded ages of 34.4 (± 3.0) x 10^6 years B.P. (Gibbs Hill Lighthouse core) and 52.4 (± 2.5) x 10^6 years B.P. (Ferry Reach Causeway core) (Fig. 1). These somewhat tentative ages indicate that the volcanics were emplaced during the period from middle Eocene to middle Oligocene.

The volcanics of the seamount are capped by a layer of marine and aeolian limestones which have a thickness of several hundred feet, and presumably represent mainly the Pleistocene Epoch.

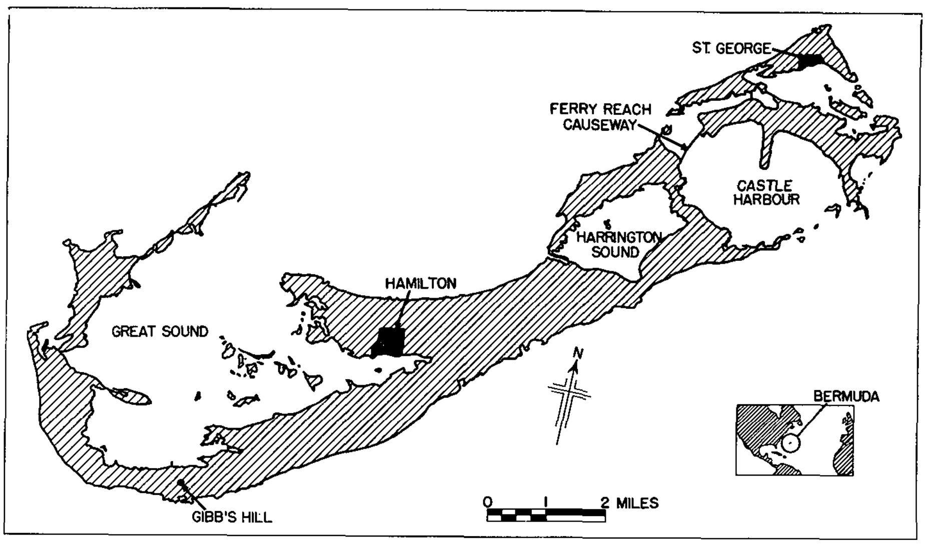

Figure 1 – Index map-location of well samples.

Purpose of this Study

To date there are only two sources of information pertaining to the interface of the volcanics and the capping sediments; namely a well near the Gibbs Hill Lighthouse (Pirsson 1914) and several borings in the vicinity of Castle Harbour (Newmann 1959). In the Gibbs Hill well (Fig. 1) basaltic lava was encountered at a depth of approximately 560 ft. below mean sea-level. In one of the Coney Island Inlet core holes near the Ferry Reach Causeway the sediment-basalt interface was found at a depth of approximately 120 ft. below mean sea level.

Since the presence of the basalt was established by these wells it seemed desirable to delineate the interface between the basaltic substratum and the capping sediments over the entire area of the Bermuda pedestal. In our opinion this type of information could possibly clarify the relationships between the two units.

Method of Investigation

The subbottom of the top of the Bermuda pedestal was investigated by means of a continuous seismic reflection survey. During the first phase we surveyed the following areas: Castle Harbour, Harrington Sound, Great Sound, and portions of the North Lagoon.

The survey was carried out using the following equipment: 1) a Bolt PAR 600 air gun equipped with a one cubic-inch chamber; 2) a 16 c.f.m. air compressor (Ingersoll Rand); 3) a hydrophone composed of three elements; 4) a Bolt band-pass filter preamplifier; 5) a trigger unit; and 6) a Gifft recorder.

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The energy source was triggered at one-half second intervals. Operating pressure was kept between 600 and 750 psi. This low pressure proved to be suitable for this type of shallow water work, keeping undue reverberation at a minimum. Both the gun and the hydrophone were towed at a depth of 1 to 2 feet and were kept approximately 30 feet apart. The band-pass filter settings were 320 cps (low cut) - 640 cps (high cut). Cruising speed was three knots. The average apparent subbottom penetration under optimum conditions amounted to about 500 ft.

The survey of Castle Harbour consisted of 16 traverses having a total length of 24 miles (Fig. 2). The areas close to Kindley Air Force Base were not surveyed, because of the presence of artificial fill deposits. The survey was particularly concentrated in the areas where patch reefs are abundant.

Geomorphology

Castle Harbour is a shallow, marine, inland water-body of almost circular shape having a diameter of about three miles and a maximum depth of less than ten fathoms. The sediments outcropping along the shorelines of Castle Harbour are mainly aeolianites and marine limestones of Pleistocene age representing mainly the Stokes Point, Walsingham, and Belmont formations (personal communication F.T. Mackenzie). Because of its shape Castle Harbour has been considered throughout the years to be of volcanic origin.

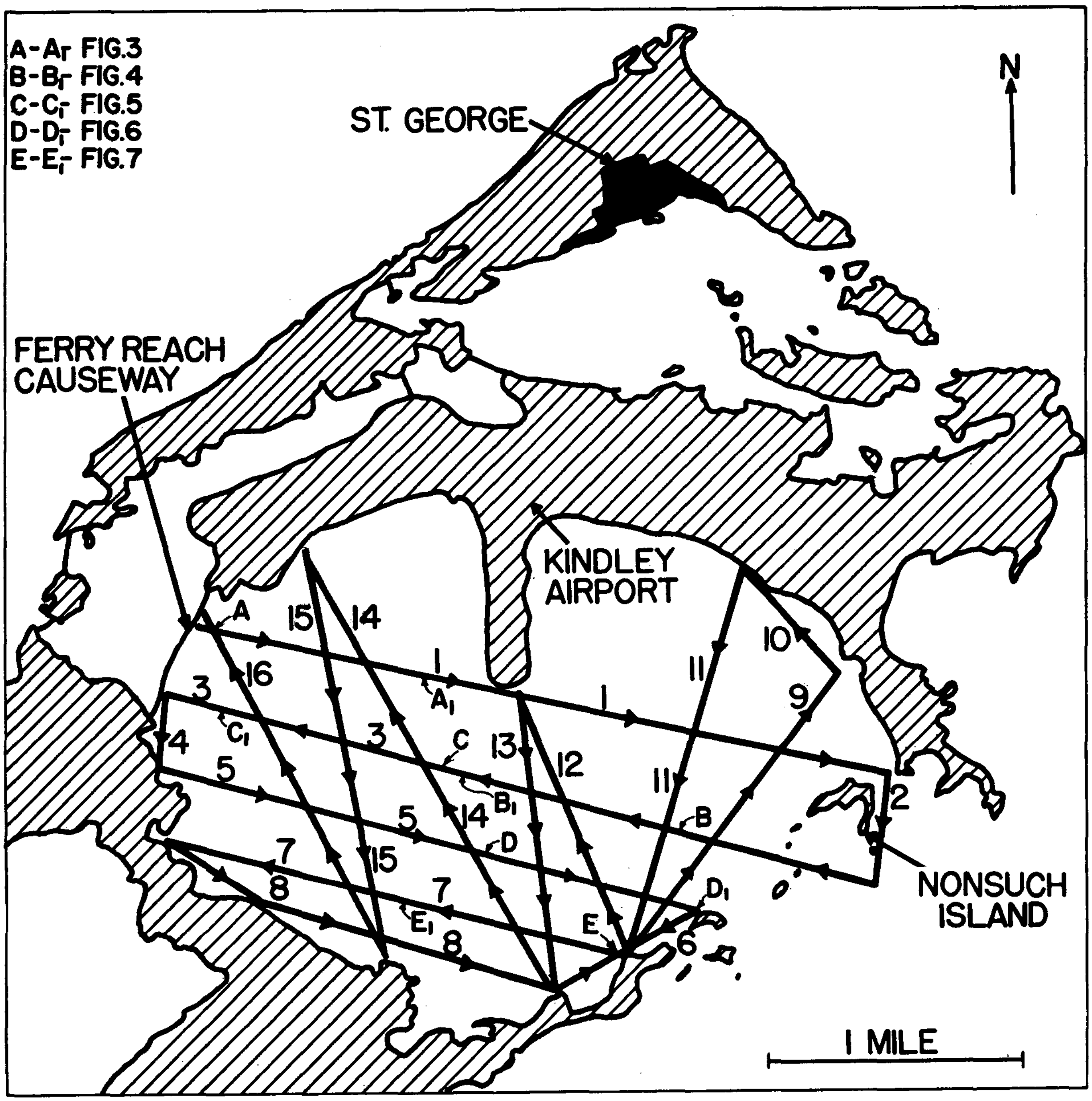


Figure 2 – Castle Harbour-Tracks of the seismic survey. The profiles of figures 3,4,5,6 and 7 are indicated by letters A through E.

Geology of the Subbottom of Castle Harbour

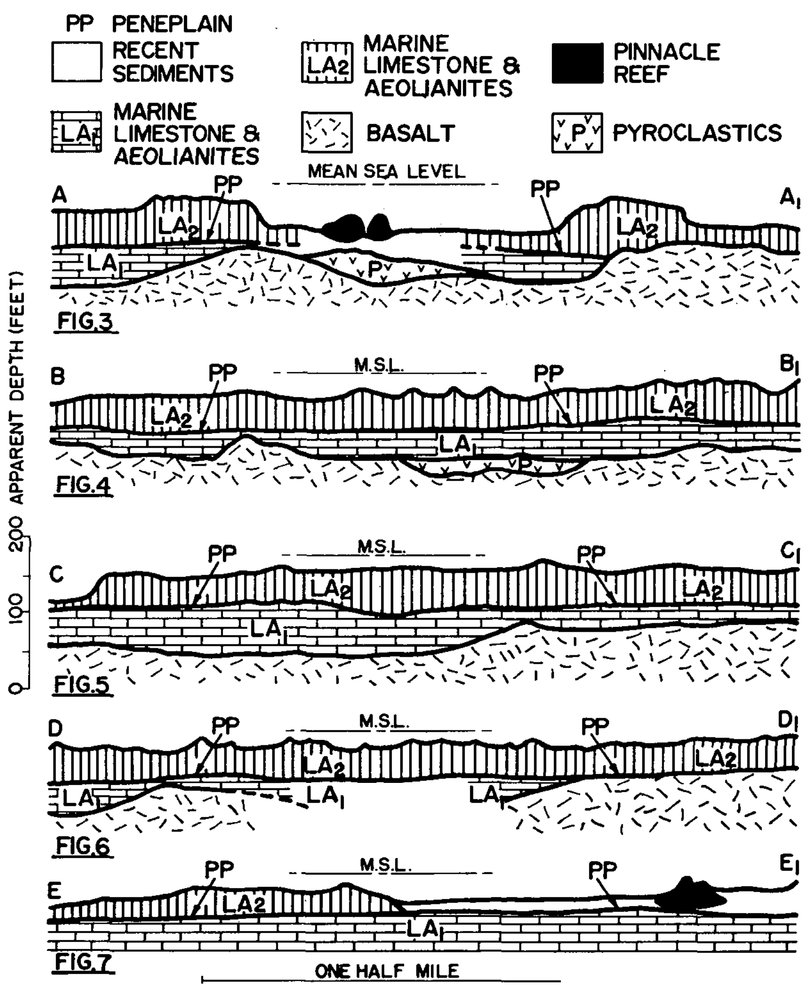
Interface volcanics-sediments:

The starting point of the seismic survey was chosen near the Ferry Reach Causeway, because of the known depth (120 ft. below mean sea-level) of the basalt in the subbottom of this area (Newman 1959). On our record of the Ferry Reach location the basalt-sediment interface appears at an apparent depth of about 140 ft. (Figs. 2 & 3). This interface is an almost consistent feature which can be traced throughout most of the sixteen traverses. On the records the outline of the interface resembles a section through a shallow, cup-like structure. The apparent depth of the rather irregular interface varies from an average of approximately 100 ft. below mean sea-level at the edges of Castle Harbour to an average of about 300 ft. below mean sea-level near the centre. It should be pointed out that these values are approximations.

The irregular, cup-like structure of the volcanic subbottom seems to confirm the earlier mentioned hypothesis of the volcanic origin of Castle Harbour. On the basis of our records we conclude that the volcanic subbottom structure could represent the remnants of an ancient caldera. However we do not completely rule out the remote possibility that this structure could have been formed by erosional processes.

The volcanic subbottom is overlain by a sequence of sediments very probably consisting of marine limestones and aeolianites. The apparent thickness of the sediments varies from several tens of feet along the edge of Castle Harbour to over 200 feet in its centre.

Within the sediments a conspicuously consistent near-horizontal reflector could be traced throughout most of the surveyed area. Examples of this reflector are shown in Figures 3,4,5,6, and 7.



Figures 3,4,5,6 and 7 – Castle Harbour – Simplified geological cross sections based on the data of the seismic survey.

Judging from the information supplied by the core material of the bore hole CI-4 near the Ferry Reach Causeway (Newman 1959) this reflector appears to be located between the Belmont and the Walsingham formations. This is a tentative correlation which requires further investigation. Assuming the stratigraphic position of the reflector to be essentially correct, the reflector must have been formed prior to 300,000 years B.P. (Table 1), because this value is the approximate lower time-limit of the Belmont formation (personal communication F.T. Mackenzie). At this stage of the investigation it is difficult to be more specific about the true nature of the reflector. Tentatively we interpret it as being a nearly flat erosional surface, i.e. a peneplain, produced by solutional processes and paleosol development.

TABLE 1

Simplified Stratigraphic Column of Bermuda

(Land, Mackenzie, Gould 1967)

Recent soil

Southampton formation
St. George's soil

Spencer's Pt. Formation
Pembroke formation
Harrington formation
Devonshire formation

Shore Hills soil

Belmont formation

Peneplain = Soil?

Walsingham formation

The peneplain is overlain by the remnants of a younger unit probably consisting of marine limestones and aeolianites. In places where this unit has been eroded numerous patch reefs, resting directly on the peneplain and still actively growing, reach to within a few feet of the low tide sea-level. Apron-shaped sediment accumulations surround most of the pinnacle reefs.

On the seismic records ill defined lenticular patterns with diffused reflectors appear in the subbottom of the Ferry Reach area. These patterns seem to correlate to pyroclastics reported by Newman (1959). Similar patterns were detected elsewhere in the subbottom of Castle Harbour and interpreted in the same manner (Figs. 3 & 4).

Conclusions

The continuous seismic survey of Castle Harbour revealed a bowl-shaped caldera-like volcanic subbottom (Fig. 8). The outline of the Castle Harbour inland marine water-body appears to be controlled by the shape of the subbottom. The volcanics are overlain by a sequence of calcareous sedimentary material which has an apparent thickness of several tens of feet near the shoreline and 200 ft.. or more toward the centre of Castle Harbour. Within the sediments a conspicuous reflector could be delineated over large portions of the basin. It is believed that this reflector represents a peneplain of post-Walsingham age (older than 300,000 years B.P.). Most of the numerous patch reefs appear to have developed on the peneplain rather than on the sea-floor of Castle Harbour. Several irregularly shaped lenses of what appears to be pyroclastic material were found resting directly on the basalt as well as within the overlying sedimentary material.

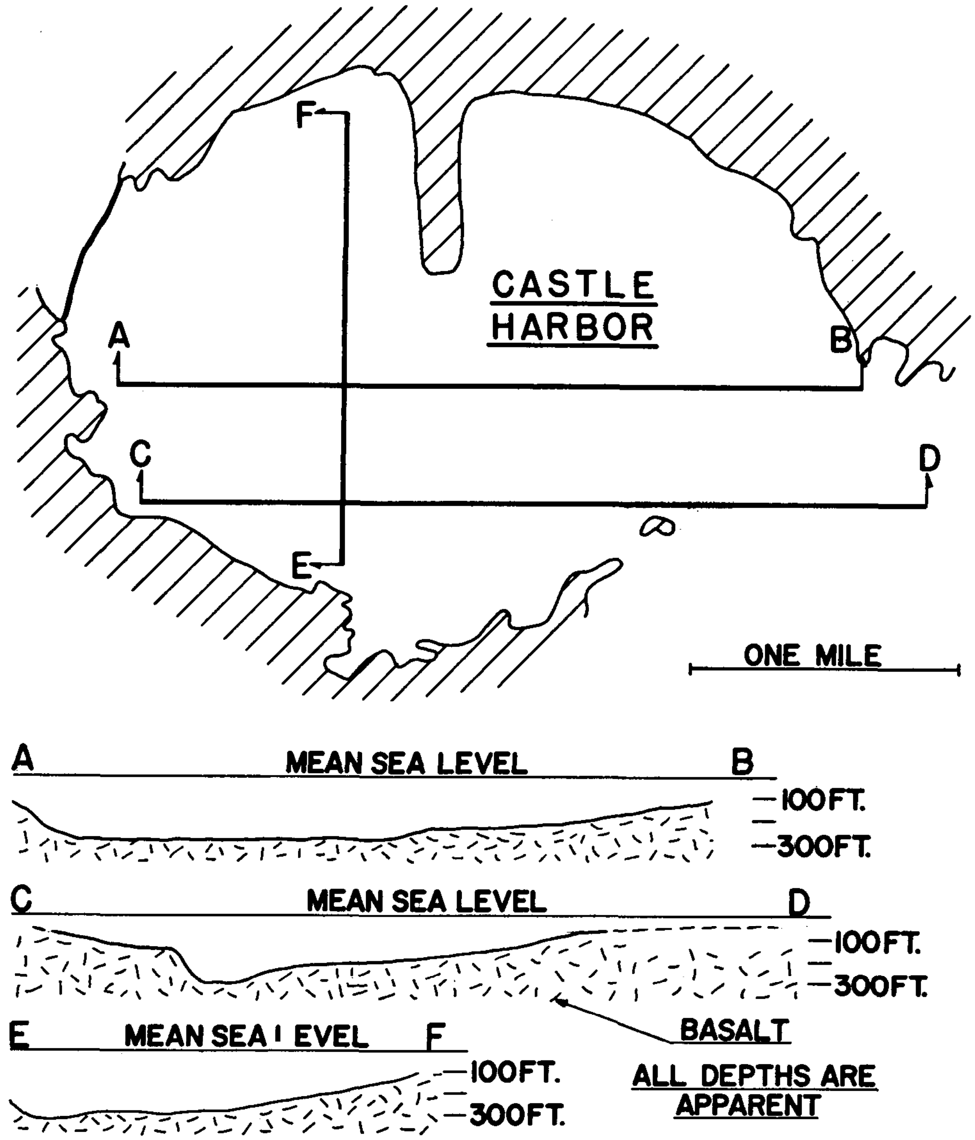


Figure 8 – Castle Harbour – Simplified cross sections of the interface basalt-sediments (sediments removed).

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References cited

GEES, R.A., 1969, The age of the Bermuda Sea Mount. Maritime Sediments, vol. 5, no. 2, p. 56-57.

LAND, L.S., MACKENZIE, F.T., GOULD, S.J., 1967, Pleistocene history of Bermuda, G.S.A. Bull., v. 78.

____________________, 1969, Field guide to Bermuda geology. (Unpublished)

NEWMAN, W.S., 1959, Geological significance of recent borings in the vicinity of Castle Harbour, Bermusa. Amer. Assoc. Adv. Sci., preprints Int. Ocean. Congr.

PIRSSON, L.V., 1914, Geology of Bermuda Island: The igneous platform. Amer. Journ. of Sci., v. 36.