

# **The Submarine Caves of Bermuda**

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### Abstract

Bermuda consists of a small group of islands situated atop a volcanic seamount in the Northwest Atlantic. The islands themselves are composed of marine and eolian, Pleistocene and Recent limestone completely capping the volcanic pedestal. Three types of submarine limestone cave morphology have so far been identified in Bermuda, with a fourth type suspected. The first type is reef caves which form at the base of the platform's fringing coral reefs in 10-20 m water depths. These caves consist of cavities and roofed fissures within the reef itself. A second type of cave occurs inland and is characterized by fissure entrances and large collapse chambers, both above and below sea level. This type of cave is primarily found on the strip of land between Harrington Sound and Castle Harbour. The third type consists of long, nearly level, anastomosing passages at depths of 18 m connecting Harrington Sound with the North Shore. During glacial periods of low sea level, these caves probably served to transport runoff waters along the surface of the water table from the then enclosed Harrington Sound to outside of the north fringing reefs. A related type of cave may connect both Harrington Sound and Castle Harbour with the South Shore. Since the south reefs are only 1 km distant from these two inshore basins, while the north reefs are 15 km, caves following the water table to beyond the south reefs would be expected to be large, single, steeply dipping linear passages.

### Zusammenfassung

Bermuda besteht aus einer kleinen Inselgruppe, die auf einer vulkanischen Kuppe im Nordwestatlantik liegt. Die Inseln selbst bestehen aus marinem und aeolischem, pleistozäenem und rezentem Kalkstein, der die vulkanische Basis voellig bedeckt. Bisher sind drei Typen submariner Kalkhoehlen identifiziert worden, und ein vierter wird vermutet. Der erste Typ ist die Riffhoehle, die sich in 10-20 m Tiefe an der Basis der Plattform-Saumriffe bildet. Diese Hoehlen bestehen aus Raeumen und gedeckten Rissen innerhalb des Riffs. Ein zweiter Typ findet sich inland und ist durch Riss-Eingaenge und Einsturz-Raeume gekennzeichnet; er kommt haunptaechlich im Landstreifen zwischen Castle Harbour und Harrington Sound vor. Der dritte Typ besteht aus langen, fast horizontalen, kommunizierenden Passagen, die in 18 m Tiefe Harrington Sound mit der Nordkueste verbinden. Zu Zeiten niedrigen Wasserstandes waehrend der Eiszeiten dienten diese Hoehlen wahrscheinlich dem Abtransport von Grundwasser entlang des Grundwasserspiegels vom damals isolierten Harrington Sound nach aussen, ausserhalb der noerdlichen Saumriffe. Ein verwandter Hoehlentyp verbindet moeglicherweise sowohl Castle Harbour wie Harrington Sound mit der Suedkueste. Nachdem die Suedriffe nur 1 km von diesen beiden Lagunen entfernt sind (im Gegensatz zu 15 km fuer die Nordriffe), kann man erwarten, dass diese dem Grundwasserspiegel folgenden Hoehlen grosse, einzelnen, steil abfallende lineare Passagen sind.

\* \* \*

Bermuda is the world's northernmost coral atoll (Garrett & Scoffin, 1977) located near latitude 32°N and longitude 65°W in the Northwest Atlantic Ocean. It consists of a volcanic platform (Pirsson, 1914) completely capped with marine and eolian, Pleistocene and Recent limestones (Land et al., 1967). The major physiographic provinces of the Bermuda Platform are an 18 m deep main terrace, a shallow rim consisting of fringing reefs, a central lagoon containing patch reefs, and a series of over 150 islands and islets composed of Pleistocene eolianites interbedded with terra-rosa paleosols (Fig. 1A).

Although considerable attention had been given to the terrestrial caves of Bermuda (Verrill, 1980; Swinnerton, 1929; Forney, 1973; Harmon, 1974; Palmer et al., 1977; Iliffe, 1979), little was known of the extensive submarine portions of these caves. In 1979, systematic exploration and mapping of the underwater caves of Bermuda was initiated utilizing advanced cave diving equipment and methodology (Exley, 1979). Dives have since been conducted in 27 different inland cave pools as well as numerous reef caves. From these explorations, three distinct types of submarine cave morphology have so far been identified.

### Reef Caves

Numerous submarine caves are found along the seaward base of the platform's fringing reefs in 10-20 m water depths (Fig. 1A). These reefs are locally referred to as boiler or breaker reefs since they extend to the sea surface and have waves breaking over them. The reefs consist primarily of encrusting coralline red algae, encrusting vermetid gastropods and *Millepora* corals with few or no other corals. Reef caves are generally tens of meters in length and consist of cavities or roofed vertical fissures within the reef itself. Stanley and Swift (1967) have proposed a solutional origin under subserial conditions for these caves stating that reef caves resemble partially collapsed caves from the interior of the island. However, there are at least three significant differences between reef caves and inland collapse caves. First, speleothems are completely absent from the reef caves, while they are very common in the inland caves - both above and below sea level. Second, the collapse features observed in reef caves cannot compare in magnitude or character with that found in inland caves. Reef caves contain only limited numbers of well rounded boulders, while extensive

angular collapse blocks are prominent features of inland caves. Third, reef caves are generally composed of small irregular rooms or roofed vertical fissures, contrasting with the inclined fissures and large collapse rooms of inland caves. Thus it is unlikely that reef and inland caves were formed by similar means. The most likely origin of reef caves is that of a constructional void within the reef being enlarged and shaped by wave and surge erosion.

### Collapse Caves (Walsingham Area)

The inland caves of Bermuda were probably formed during periods of continental glaciation when sea level was as much as 100 m below its present level. Consequently, Bermuda was a much larger island since the entire top of the platform was emergent and thus, unlike today, substantial bodies of fresh ground water were present. Cave formation probably occurred primarily in the phreatic zone along the surface of this paleo water table (Palmer et al., 1977). Collapse of roof rock and deposition of secondary dripstone contributed to the isolation of the caves. As interglacial sea levels rose, substantial portions of the caves were drowned in sea water. Today, most of Bermuda's inland caves contain deep tidal sea level pools, indicating that the terrestrial sections may only represent a small portion of Bermuda's cave systems with the majority of cave passages, including the original phreatic passages lying deep below present sea level.

The Walsingham area, located between Harrington Sound and Castle Harbour (Fig. 1B), contains the largest known concentration of caves in Bermuda - approximately 100-150 caves. These caves are characterized by fissure entrances and large collapse chambers (Palmer et al., 1977). Dives in these caves have reached depths of -24 m where the traversable cave terminated in collapse. It is possible that these large chambers have resulted from collapse into deeper passages lying at the limestone-basalt interface. This interface may be as shallow as -35 m in the Walsingham area (Newman, 1959). During periods of lower sea level, ground water would penetrate the very porous eolianite limestone until reaching the impermeable basalts. At the interface, horizontal transport of the ground water would likely have formed large solutional cave passages. The underwater portions of the Walsingham caves closely resemble the terrestrial morphology found in the same caves, even to the variety of large speleothems found at all depths within the caves.

### Passage Caves (Shelly Bay Area)

Dives in inland caves in the Shelly Bay area of Bermuda (Fig. 1B) have revealed very extensive caves with long, nearly level, anastomosing passages reaching from Harrington Sound to the North Lagoon (Iliffe & Warner, 1980). The largest of these caves, and also the longest cave in Bermuda - terrestrial or marine - is the 1.5 km long, totally underwater Green Bay Cave System (Fig. 2). This cave and other caves in the Shelly Bay area probably acted to transport water between the nearly enclosed Harrington Sound and the North Lagoon or possibly even the North Rim, 15 km distant. The 18 m average depth of these caves corresponds with the depth of the main reef terrace indicating that both features may have formed during a stationary stand of sea level at this position.

### Devil's Hole Caves

A fourth type of submarine cave, as yet still theoretical, may exist in the area of Devil's Hole, located between Harrington Sound and the South Shore (Fig. 1B). Four caves containing sea water pools are known from this area. However, only a few preliminary dives have been made in these caves without any significant discoveries. Since the distance between Harrington Sound and the South Rim is only one km, it is possible that caves from the Devil's Hole area may consist of large, single, steeply dipping linear passages transporting water from the then totally enclosed Harrington Sound during low stands of sea level. Even today, approximately 50% of the tidal exchange in Harrington Sound is through caves.

### Summary

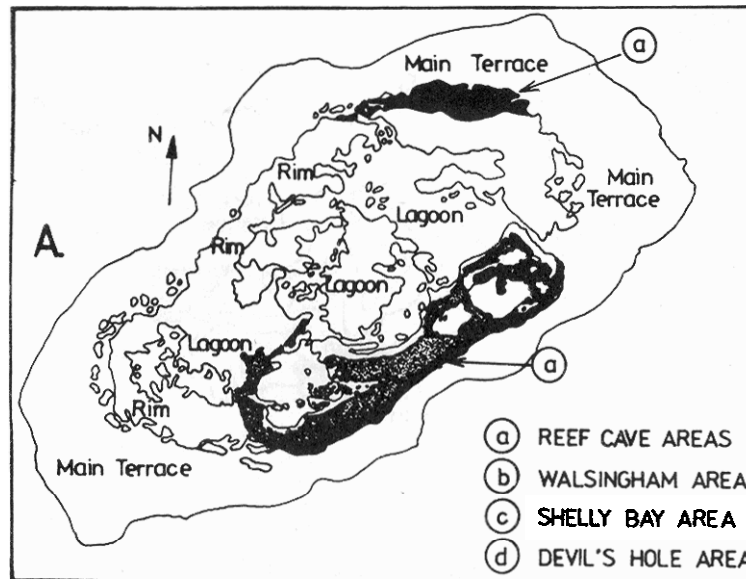
Diving explorations in Bermuda have so far identified three different types of submarine cave morphology. Reef caves are probably of constructional origin, modified by erosion. Caves in the Walsingham area are probably the product of collapse into deeper solutional voids. Caves at Shelly Bay, and possibly at Devil's Hole, probably formed in response to water transport into and out of the nearly enclosed Harrington Sound.

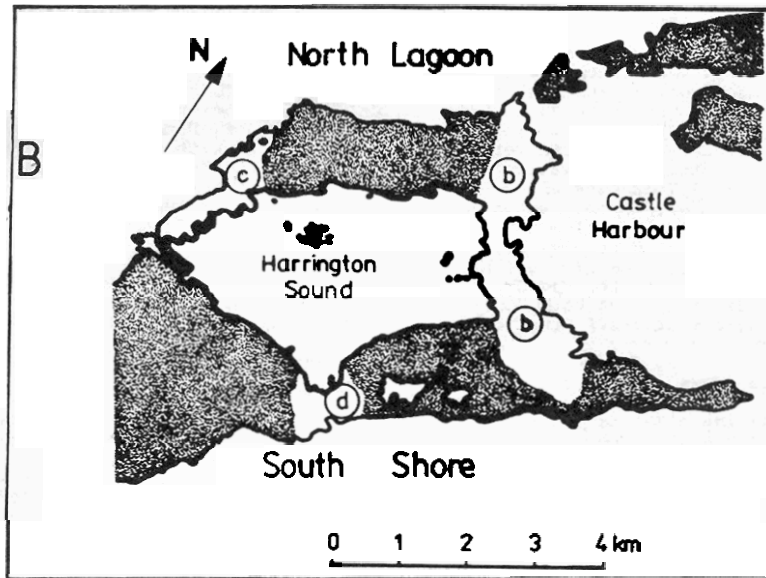
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### References

- Exley, S. (1979). Basic Cave Diving. National Speleological Society, Hunstville, AL., USA.  
Forney, G.G. (1973). Bermuda's caves and their history. *J. Spel. Hist.*, 6:89-103.  
Garrett, P. & T; P. Scoffin (1977). Sedimentation on Bermuda's atoll rim. *Proceedings, Third International Coral Reef Symposium, University of Miami, FL., USA*, p. 87-95.  
Harmon, R. S. (1974). An introduction to the caves of Bermuda. *Can. Caver*, 6:52-57.  
Iliffe, T.M. (1979). Bermuda's caves; A non-renewable resource. *Environ. Conserv.*, 6:181-186.  
Iliffe, T.M. & B. Warner (1980). Mid ocean cave diving. *Underwater spel.*, 7:46-48.  
Land, L.S., F.T. Mackenzie & S.J. Gould (1967). Pleistocene history of Bermuda. *Bull. Geol. Sec. Am.*, 78:993-1006.  
Newman, W.S. (1959). Geological significance of recent borings in the vicinity of Castle Harbour, Bermuda. *Am. Assoc. Adv. Sci. Preprints Intern. Oceanog. Cong.*: 46-47.  
Palmer, A.N., M.V. Palmer & J. M. Queen (1977). Geology and origin of the caves of Bermuda. *Proc. Seventh Intern. Congr. Speleol.*, Sheffield, UK, p. 336-339.  
Pirsonn, L.V. (1914). Geology of Bermuda Island: The Igneous Platform. *Am. J. Sci.*, 38: 189-206; 331-334.  
Stanley, D.J. & D. J. P. Swift (1967). Bermuda's southern aeolianite reef tract. *Sci.*, 157:677-681.  
Swinnerton, A.C. (1929). The caves of Bermuda. *Geol. Mag.*, 66:79-84.  
Verrill, A. H. (1980). The Caverns of Bermuda. *Trop. and Sub. Trop. Am.*, 1:107-111.





Figures 1A and 1B: Physiographic Provinces and Cave Areas in Bermuda

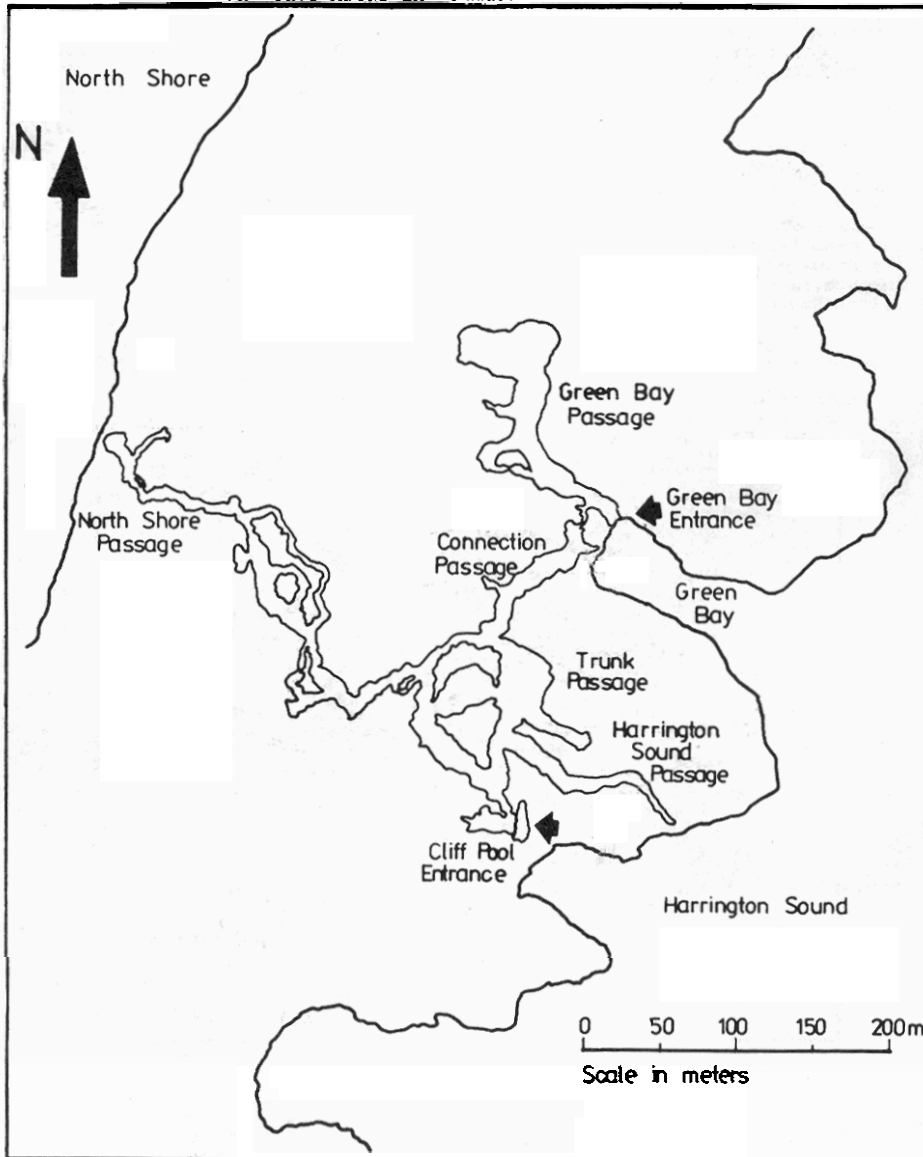


Figure 2: Map of Green Bay Cave System