

Electronic supplementary material

Text and table headings

ESMT 1

Documentary limits on a time of inferred overwash at Anegada

ESMT 2

Radiocarbon ages from Anegada. See section 2 of main text for calibration methods and references.

Figure captions

ESMF 1

Eyewitness records of storm surge and storm waves at Anegada. **(a-c)** Flooding of The Settlement by the storm surge from Hurricane Donna on September 5, 1960. Triangles in **a** show places flooded or not according to eyewitnesses interviewed in 2008. Paired, opposing triangles denote estimated limits, queried where doubtful. The eyewitness in **b**, Lucia Frances, points to her estimate of the water level. In **c**, Darvin Potter shows how he helped two boys, ages 5 and 7, wade through knee-deep water. **(d)** Winter storm waves near Keel Point, March 21, 2008.

ESMF 2

Examples of beach-ridge topography along Anegada's north shore.

ESMF 3

Stratigraphy at site 19, west side of Red Pond

ESMF 4

Stratigraphy at site 13, southernmost Red Pond

ESMF 5

Stratigraphy at sites 8 and 16, southwesternmost Bumber Well Pond

ESMF 6

Stratigraphy in two breaches. Site of **b** plotted in Fig. 3d.

ESMF 7

Brain coral embedded in sandy deposits north of Bumber Well Pond (location, Fig. 5). **(a, b)** Upper part of coral before excavation. **(c-e)** Pit dug to horizontal limestone surface at 30 cm depth.

ESMT 1 Documentary limits on a time of inferred overwash at Anegada

Summary

As judged from written records, the main overwash inferred in this paper predates A.D. 1800. Such a catastrophe probably would have registered in Anegada's written history had it occurred after that. Earlier documents about the island are sparse and sketchy enough for catastrophic overwash before the 1770s to have gone unrecorded.

Maps

Records from a Spanish lawsuit in 1515 include Anegada among the places named in 1493 during Columbus's second voyage to the New World (Morison, 1942, p. 78, 79, 90). The island possibly appears on the first map of the New World by de la Cosa (1500), as a shapeless blob surrounded by dots (reefs?), but without an attached name. Ortelius (1592) drew Anegada as a three-pronged shape and annotated it by name. Maps from the 17th century continue to show the island as a shapeless blob.

Anegada means flooded in Spanish, and this name was translated in French maps to Ile Noyée or Noyie (flooded) (e.g., de Fer, 1705).

Popple (1733) was the first to draw the island as an elongate shape in an E-W direction. Jefferys's (1775) and Richmond's (1779) maps show a slightly more realistic shape of the island extending in a WNW-ESE direction with an attempt to draw the surrounding reefs. It is difficult to know when and how the better knowledge of island geography was obtained, because Jefferys himself was an engraver, not an explorer, and he died in 1771, prior to the publication of his map. Jefferys's map is presented as compilation from unnamed British and Danish maps and Richmond does not provide sources.

A realistic shape of the island and surrounding reefs with some bathymetric soundings appear in Spanish maps resulting from surveys by the Spanish Brigantines S.M. Descubridor and Vigilante from 1793-1794 (Anonymous, 1793-1794). A partial map probably from the later part of the 18th century by an unknown author shows a stylized pond of fresh water in the western side of the island (Map MNM_0023_B_0002, Museo Naval de Madrid). An 1813 map by Blachford, based on an 1811 survey by Lockwood shows a relatively accurate map of the island, including ponds on the island, the reefs, and locations of shipwrecks. In addition, it describes the currents around the island, and location of fresh water sources.

The earliest realistic depiction of the island's interior was made by Robert Hermann Schomburgk (b. 1804). He surveyed the island and its reefs in 1831. His 1832 publication provides, in addition to a map, details about the island's physical and cultural geography (Schomburgk, 1832, p. 152-170).

Explorers' descriptions

Schomburgk was able to map and describe Anegada carefully because he spent time on the island itself. Most previous observations, by contrast, were probably made from afar by mariners scanning the island's low profile (highest point 7 or 8 m above sea

level) from outside the fringing reef to the north (Fig. 2) and from outside patch reefs to its south.

A Spanish geography book (de Velasco, 1574) describes the island as 6-7 leagues from east to west. A league commonly being about 3 miles, or 5 km, this estimate makes the island twice its present east-west length of 17 km. The larger size can perhaps be explained if the observations included Horseshoe Shoal, a reef that extends 20 km southeast of the island, and which locally extends above sea level. de Laet (1640) also described Anegada as 7 leagues long.

Labat (1705) traveled within ¼ mile of Anegada in or soon after 1701. He described the island as 4 leagues long, very low except for the center, and with trees and mangroves growing in abundance. He further noted, “It doesn't look like the sea rises high enough to cover it [the island] entirely, even in the largest storms”.

According to text on Jefferys's (1775) map, “the island is almost entirely covered by the sea at the spring tides” (Jefferys, 1775). Books by Kitchin (1778) and Bernoulli (1781) contain the same comment. Bernoulli (1781) claimed that Labat and de Laet had ascribed the island's name to flooding that occasionally covered the island completely. However, neither de Laet nor Labat mention occasional flooding in the documents cited above. Mention of occasional flooding disappeared from subsequent maps (e.g., Richmond, 1779; Anonymous, 1793-1794; Blachford, 1813), in addition to being absent from earlier maps and literature cited above. It is unclear whether anyone observed extensive flooding of Anegada in the years before Jefferys's death in 1771, or whether one source made it up and the other two sources copied this comment without verification.

Human settlement

Although archaeological evidence suggests the presence of pre-Columbian visitors or inhabitants (Davis and Oldfield, 2003), the word “deserted” appears next to the name of Anegada in maps by Coronelli (1688) and de Fer (1705). An English compilation of older books (Richardson et al., 1759) describes the island as being deserted and being known for its hummingbirds and painted crabs. The “Diccionario Geográfico de las Indias Occidentales o America” (de Alcedo, 1786-1789) describes Anegada as deserted and lacking fresh water. The island was known as a temporary shelter to pirates and buccaneers during the late 17th and early 18th centuries and was rumored to have treasures buried in it (Jefferys, 1775; Kitchin, 1778).

European settlement of the British Virgin Islands (BVI) probably began with the Dutch around 1620 (Pickering, 1983). As many as a dozen families lived on Tortola, 50 km southwest of Anegada, when the British claimed it in 1672. Tortola's population then included 80 from British isles (Dookhan, 1975, p. 255). Britain formally gained sovereignty over Tortola and two neighboring islands, Virgin Gorda and Jost Van Dyke, around 1735. By then a Quaker colony had taken up residence in Tortola, persisting there until 1763. African slaves were producing sugar and cotton on plantations, and copper was being mined on Virgin Gorda. The first legislature, convened in 1773, had eight representatives from Tortola, two from Virgin Gorda, and one from Jost Van Dyke. A packet sailed monthly to Tortola from 1785 to 1819. A hurricane there on September 21 and 22, 1819, caused at least 94 deaths and put plantations out of business (Dookhan, 1975, p. 255).

Settlement had spread to Anegada by 1784. By then the settlers consisted of three families and their slaves. Tradition has them reaching Anegada in 1776 and being its sole inhabitants until 1784 (Faulkner, 2006 and oral communication, 2009). An endnote in a BVI history gives the 1784 date only (Dookhan, 1975, p. 67). In a letter dated July 3, 1794, one of the Methodist church leaders in Tortola wrote that the church had “also a small society in Anegada.” In May 1796 this society numbered 82 (Pickering, 1983), all of them slaves (Faulkner, 2006). The first settlers established “The settlement” in the middle of the south coast of the island, which to date remains the only town on Anegada. According to Darvin Potter (ESMF 1), interviewed in 2009, that place was chosen because it is far from the island’s northwest tip, the easiest landing spot for raiding pirates. An attachment to the Blachford (1813) map enumerates Anegada’s human inhabitants as of 1811 (197 in all) along with its sheep, cattle, and bales of cotton.

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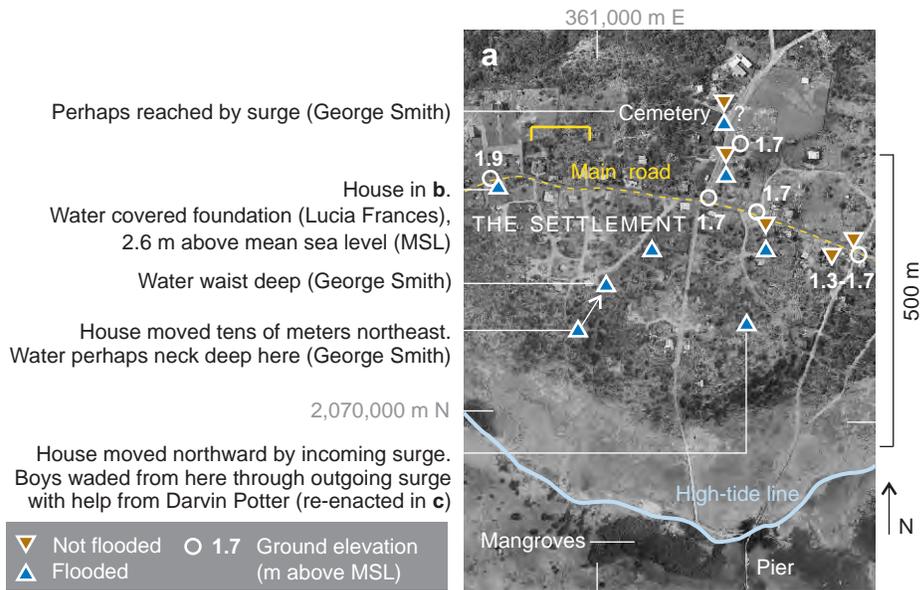
ESMT 2 Radiocarbon ages. Grouped and ordered as plotted in Figure 8b.

Lab code	Field code	Depth (cm)	Pond; area	Material	Stratigraphic position	Age relative to inferred overwash	d13C	Age and 1 std dev error, 14C yr BP	Range at 2 std dev, calibrated years AD (+) or BC (-)*
<i>Plant detritus likely younger than mud cap</i>									
NOSAMS-	71383	AN09 31 V	55 Big Finger	Leaf	3 cm below lowest microbial mat	Years after	-24.9	110 35	1680 1954
NOSAMS-	71382	AN09 31 U	55 Big Finger	Red-mangrove propagule (entire)	3 cm below lowest microbial mat	Years after	-21.9	185 25	1656 1952
<i>Leaves and a twig in mud cap</i>									
NOSAMS-	71378	AN09 16 J	20 Bumber Well; S	Leaf fragments (perhaps >1 leaf)	In capping mud	~ same	-26.5	30 25	1699 1956
NOSAMS-	66811	AN 8 5	20 Bumber Well; S	Leaf	In mud 8.5 cm above shelly sand sheet	~same	-28.6	85 25	1691 1954
NOSAMS-	71379	AN09 16 L	25 Bumber Well; S	Leaf fragments (perhaps >1 leaf)	In capping mud	~ same	-24.3	130 25	1677 1953
NOSAMS-	71377	AN09 15 G	25 Red; NW arm	Leaf	In capping mud	~ same	-24.4	135 25	1674 1953
NOSAMS-	66812	AN 105	8 Bumber Well, upper	Leaf	Below lowest microbial mat; in capping mud?	~ same	-26.9	145 30	1668 1953
NOSAMS-	71372	AN09 13 A	15-20 Red; S narrows	Leaf (1 fragment when washed)	In capping mud	~ same	-23.4	160 25	1665 1953
NOSAMS-	71376	AN09 15 I	25 Red; NW arm	Leaf	In capping mud	~ same	-27.3	215 25	1646 1951
NOSAMS-	71380	AN09 19 N	35-36 Red; W shore	Twig, forked, 3 cm long, 0.5 cm diam	In capping mud	~same	-25.2	225 30	1641 1951
<i>Articulated bivalves in sand and shell unit</i>									
NOSAMS-	71951	AN09 13 a	24-26 Red; S narrows	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-1.8	590 25	1662 1811
NOSAMS-	71953	AN09 13 c	24-26 Red; S narrows	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-3.9	695 25	1535 1671
NOSAMS-	71952	AN09 13 b	24-26 Red; S narrows	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-3.5	730 35	1497 1659
NOSAMS-	75708	AN09 14 a	18-24 N of Bumber Well	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-3.6	980 30	1319 1436
NOSAMS-	75709	AN09 14 b	18-24 N of Bumber Well	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-3.43	4390 30	-2701 -2469
NOSAMS-	75710	AN09 14 c	18-24 N of Bumber Well	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-2.61	4320 30	-2597 -2410
NOSAMS-	75711	AN09 14 d	18-24 N of Bumber Well	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-3.91	2070 25	228 404
NOSAMS-	75712	AN09 16 a	30-32 Bumber Well; S	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-3.08	1090 25	1237 1348
NOSAMS-	75713	AN09 16 b	30-32 Bumber Well; S	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-3.46	660 25	1558 1694
NOSAMS-	75714	AN09 16 c	30-32 Bumber Well; S	<i>Anomalocardia</i>	In sheet of sand and shell	Before	-0.5	670 25	1550 1687

Lab code	Field code			Depth (cm)	Pond; area	Material	Stratigraphic position	Age relative to inferred overwash	d13C	Age and 1 std dev error, 14C yr BP	Range at 2 std dev, calibrated years AD (+) or BC (-)*	
<i>Mangrove roots below sand and shell unit</i>												
NOSAMS-	71375	AN09	13 E	24-26	Red; S narrows	Mangrove root or stem	Below shelly bed	Before	-25.6	325	30	1480 1644
NOSAMS-	71852	AN09	13 F	24-26	Red; S narrows	Mangrove root or stem	Below shelly bed	Before	-25.5	365	30	1449 1634
<i>Gastropods below sand and shell unit</i>												
Beta-	243087	AN	8 4b		Bumber Well; S	Cerithid gastropod	Uppermost 1 cm of shelly mud	Before	3.2	790	40	1453 1629
NOSAMS-	66646	AN	8 4d		Bumber Well; S	Cerithid gastropod	Uppermost 1 cm of shelly mud	Before	3.0	870	25	1419 1500
Beta-	243086	AN	8 4a		Bumber Well; S	Cerithid gastropod	Uppermost 1 cm of shelly mud	Before	2.2	880	40	1389 1523
Beta-	243088	AN	8 4c		Bumber Well; S	Cerithid gastropod	Uppermost 1 cm of shelly mud	Before	0.0	1470	40	826 1027
NOSAMS-	66647	AN	8 43		Bumber Well; S	Cerithid gastropod	Uppermost 1 cm of shelly mud	Before	-2.3	2490	30	-331 103
<i>Ambiguous</i>												
NOSAMS-	71381	AN09	19 P	19.5-20.0	Red; W shore	Microbial mat	Above capping mud	Uncertain	-17.2	315	25	1490 1645
NOSAMS-	71384	AN09	31 T	125	Big Finger	Leafy peat	Lowest organic deposits in pond fill	Uncertain	-24.8	280	25	1515 1662

* Calibration data: IntCal04 for plant fragments and Marine04 for shells. Delta R treated as negligible

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Geo-referenced image from airphoto taken 2002; elevations by digital GPS, 2009



When interviewed in 2008, Darwin Potter, George Smith, and Egbert (Cap) Wheatley all stated that 1960 Hurricane Donna's winds first blew hard from the north, next calmed, and finally blew hard from the southwest. All said the storm surge began soon after the calm, and that it entered and withdrew within a half-hour.

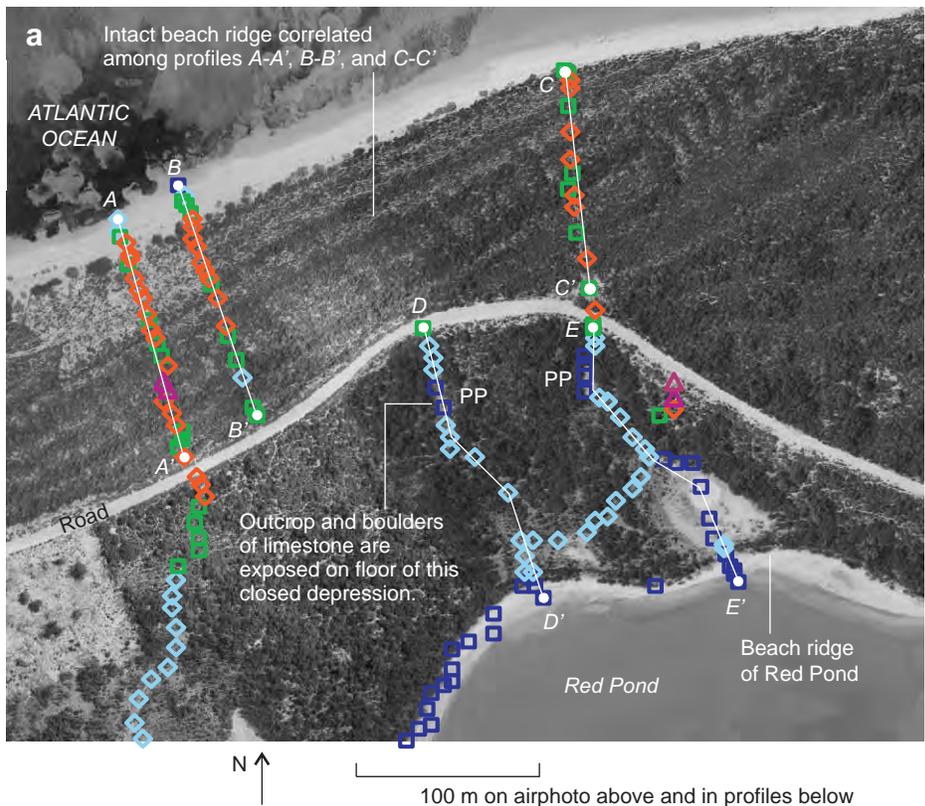
Referring to a wrack line and to houses that were flooded or not, the three men agreed for the most part that the surge did not cross The Settlement's east-west arterial (**a**, above). Mr. Smith, however, recalled flooding as far as the cemetery, 150 m farther north. A fourth informant, Lucia Frances, stated that the water covered the foundation of a house along the main road (**b**). Mr. Potter said that two boys, ages 5 and 7, waded with him through the receding surge; he gave a hand to each (**c**).

Hurricane Donna left mud and sand on house floors in The Settlement according to Mr. Smith, who recalled cleaning them up. Mr. Potter and Mr. Wheatley in 2008 recalled that the waters contained mud and floating debris, which included a house moved tens of meters inland. Neither Mr. Potter nor Mr. Wheatley recalled any deposit of sand or rocks.

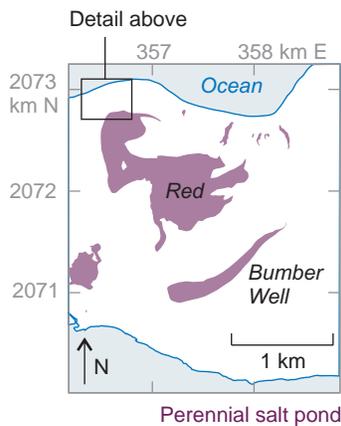
Anegada ESMF 1, page 2 of 2



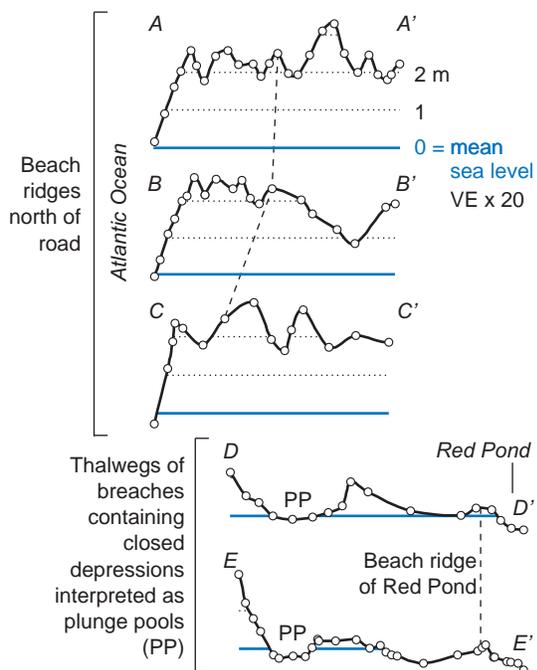
Keel Point, Anegada, March 21, 2008

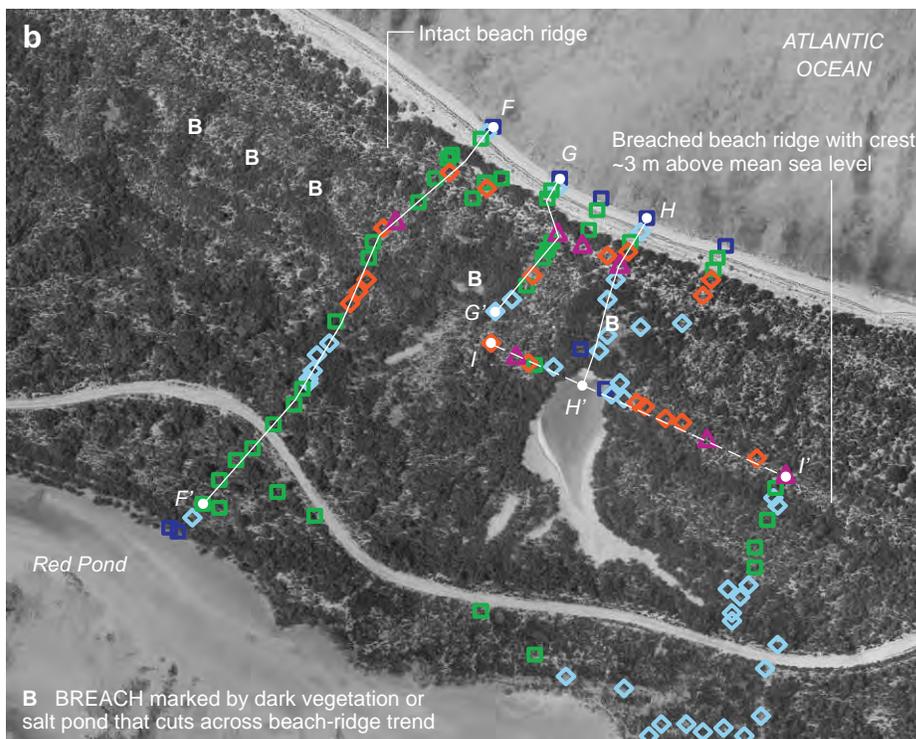


ELEVATION in meters relative to mean sea level. By differential GPS, 2009



AIRPHOTO taken 2002. Coordinates of borders, km, UTM zone 20Q: 2072.7-2073.1 N, 356.3-356.8 E

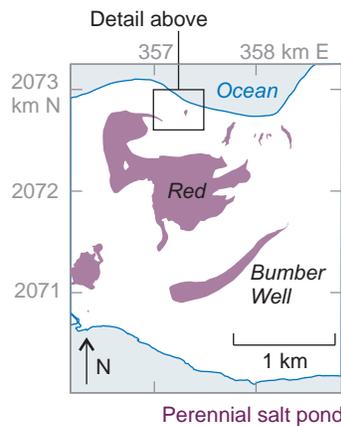




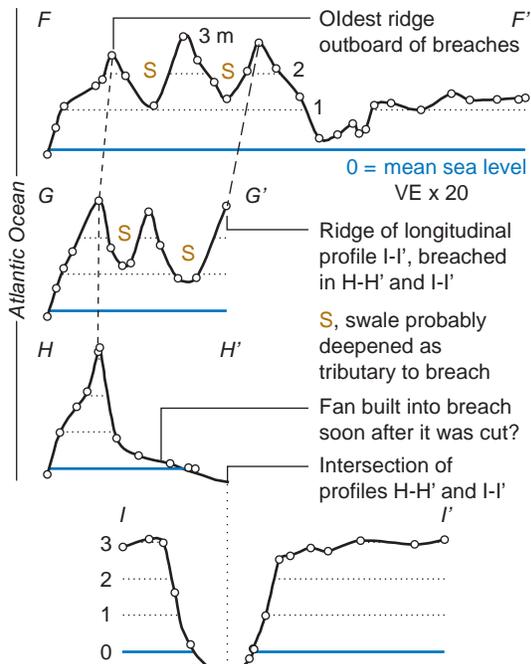
N ↑
100 m on airphoto above and in profiles below

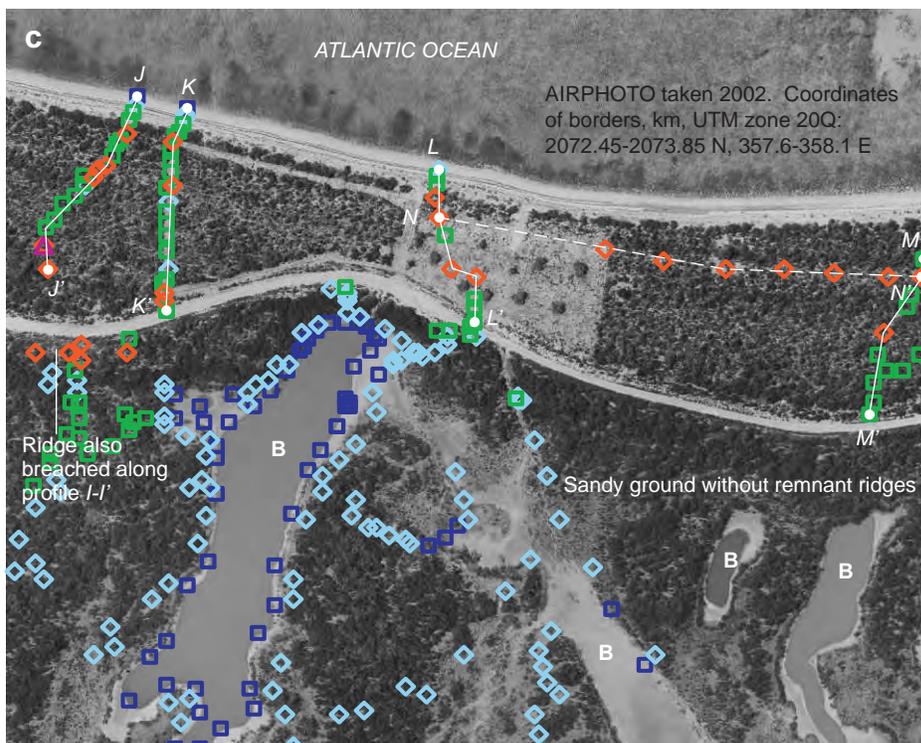
ELEVATION in meters relative to mean sea level. By differential GPS, 2009

- <0
- ◊ 0-1
- 1-2
- ◊ 2-3
- ▲ 3-4



AIRPHOTO taken 2002. Coordinates of borders, km, UTM zone 20Q: 2072.6-2073.0 N, 357.0-357.5 E

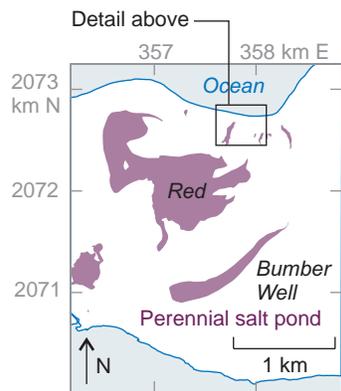




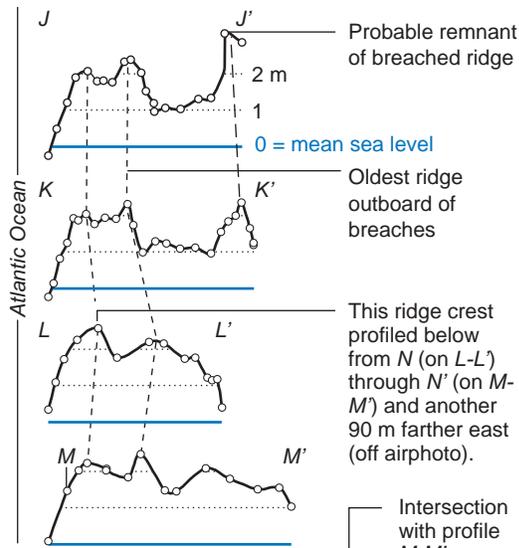
B BREACH marked by salt pond or salt flat

ELEVATION in meters relative to mean sea level. By differential GPS, 2009

- <0
- ◊ 0-1
- ◻ 1-2
- ◈ 2-3
- ◄ 3-4



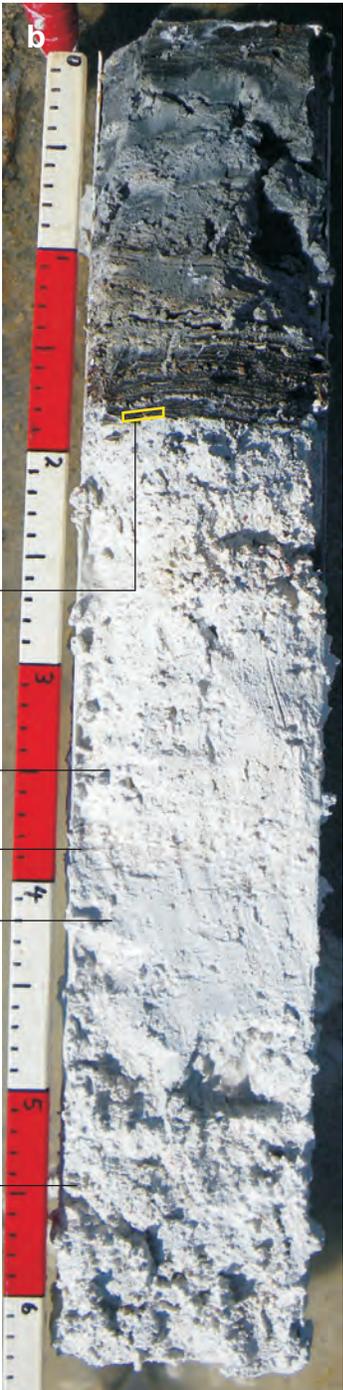
100 m on airphoto above and in profiles below



Intersection of profile N-N' with profile L-L'

VE x 20

Anegada ESMF 3



Age inversion perhaps caused by bacterial addition of old carbon to buried microbial mat

Lowest 0.5 cm of mat ¹⁴C dated to **AD 1490-1645** (NOSAMS-71381)

Position of forked twig ¹⁴C dated to **AD 1641-1951** (NOSAMS-71380)

Contact labeled in **a**

Fine sand with *Homotrema* grains

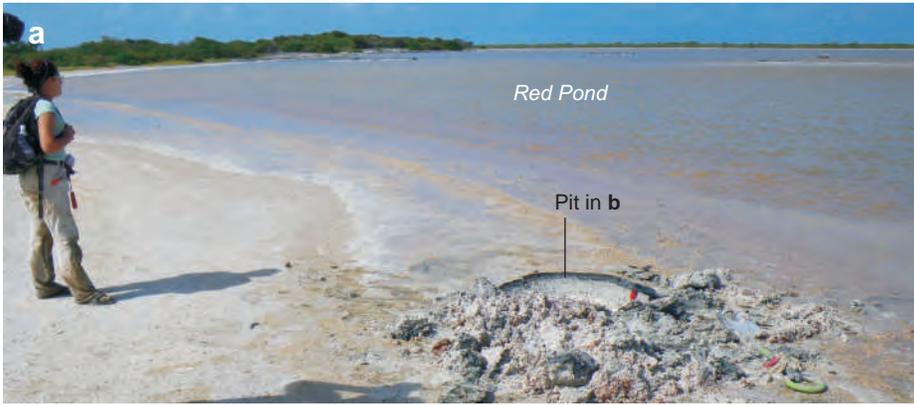
SHELLY MUD

Lime mud with few cerithids

5 cm

Sandy lime mud with many shells

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Stripes on
shovel handle
10 cm long

Anegada ESMF 4, page 2 of 2

c

Black microbial mats

Shelly mud intercalated with green microbial mats

Mud cap

Muddy shell hash

Mud with mangrove roots



5 cm

¹⁴C AGES

Lab number (NOSAMS)
in parentheses

Leaf in d

AD 1665-1953 (71377)

Articulated *Anomalocardia*

AD 1662-1811 (71951) (photo e)

AD 1535-1671 (71953) (f)

AD 1479-1659 (71952) (g)

Mangrove roots

AD 1480-1644 (71375)

AD 1449-1634 (71852)



e



f



g



1 cm

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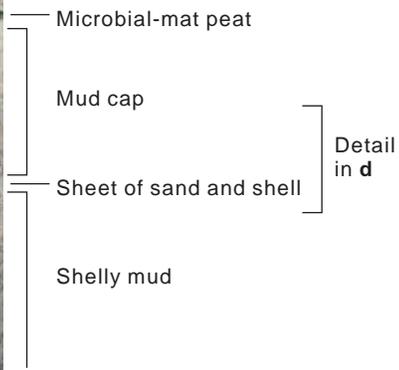


View to north-northeast across southwest end of Bumber Well Pond, 16 March 2008



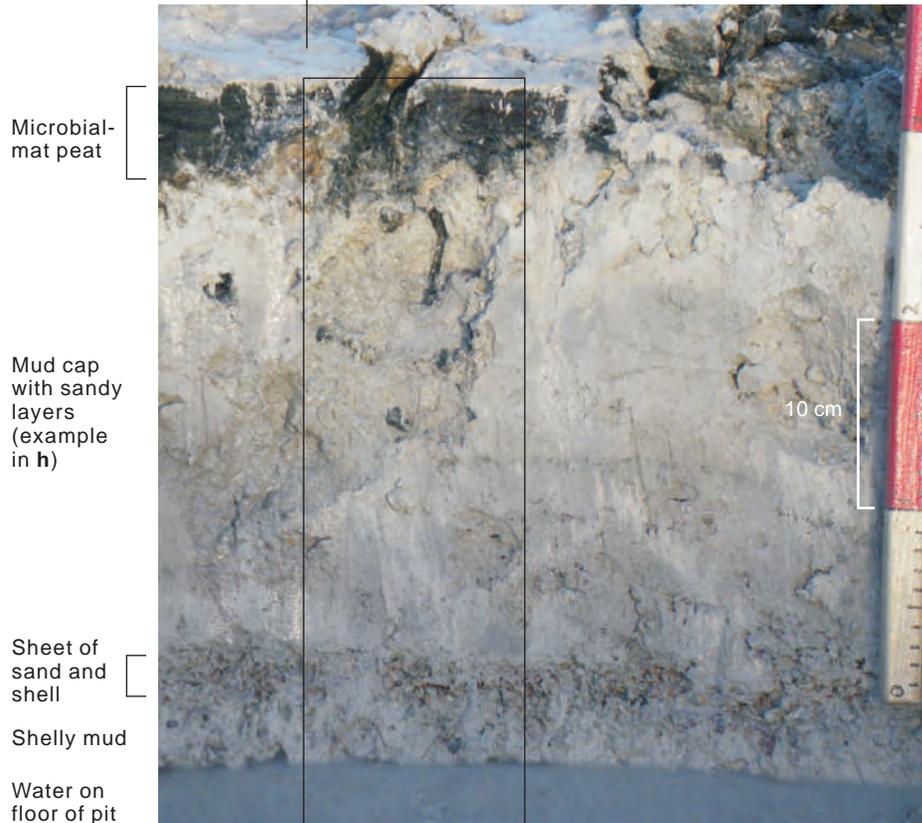
View to south-southeast across southwest end of Bumber Well Pond, 22 February 2009

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e

Pit-derived mud and pond foam coating microbial mat



Microbial-mat peat

Mud cap with sandy layers (example in h)

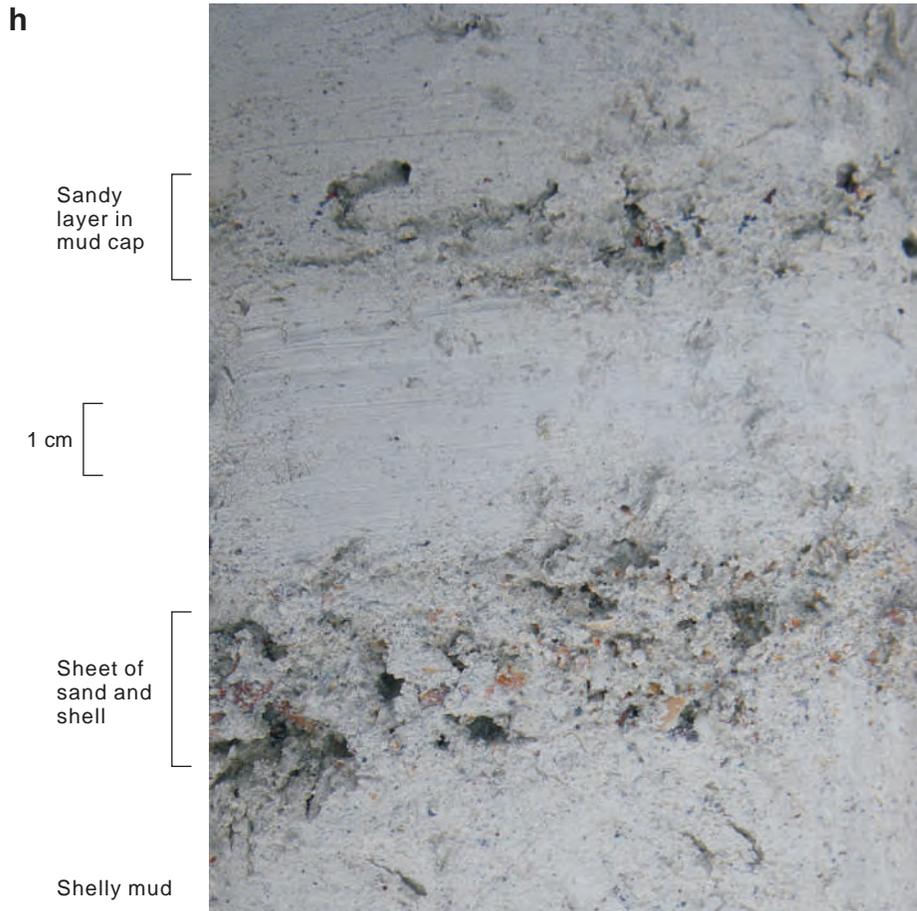
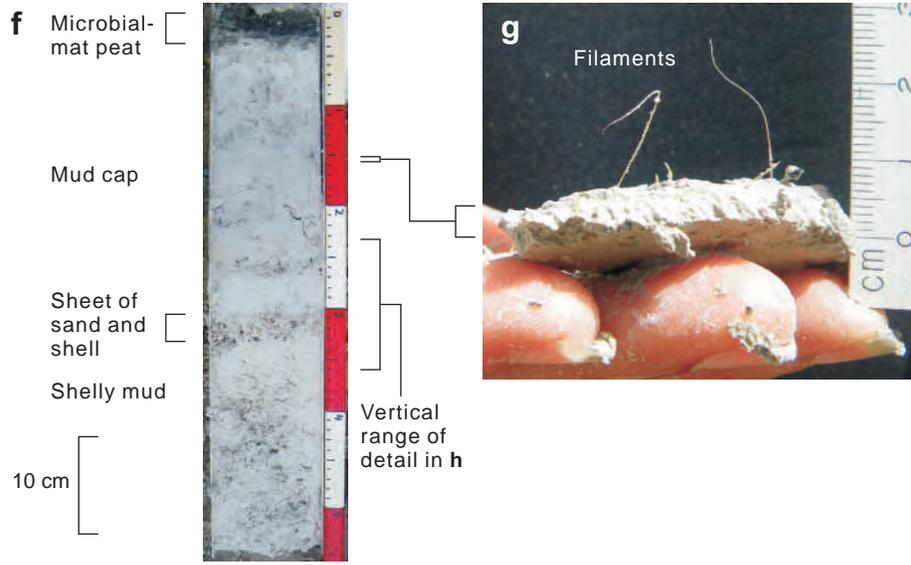
Sheet of sand and shell

Shelly mud

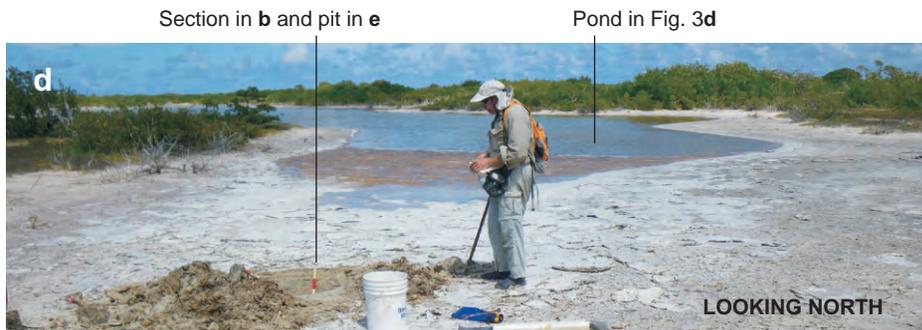
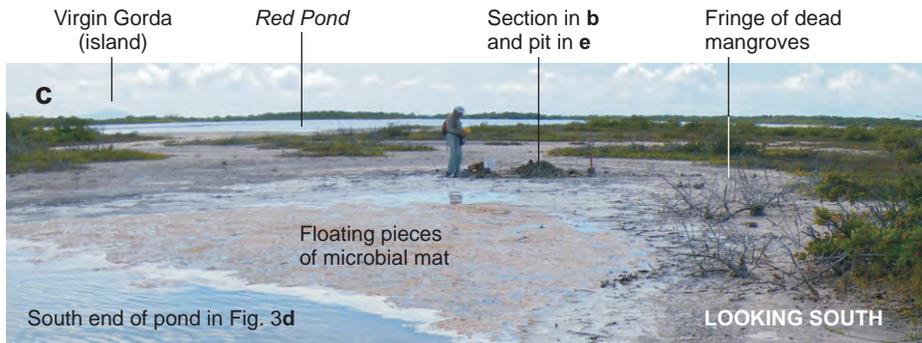
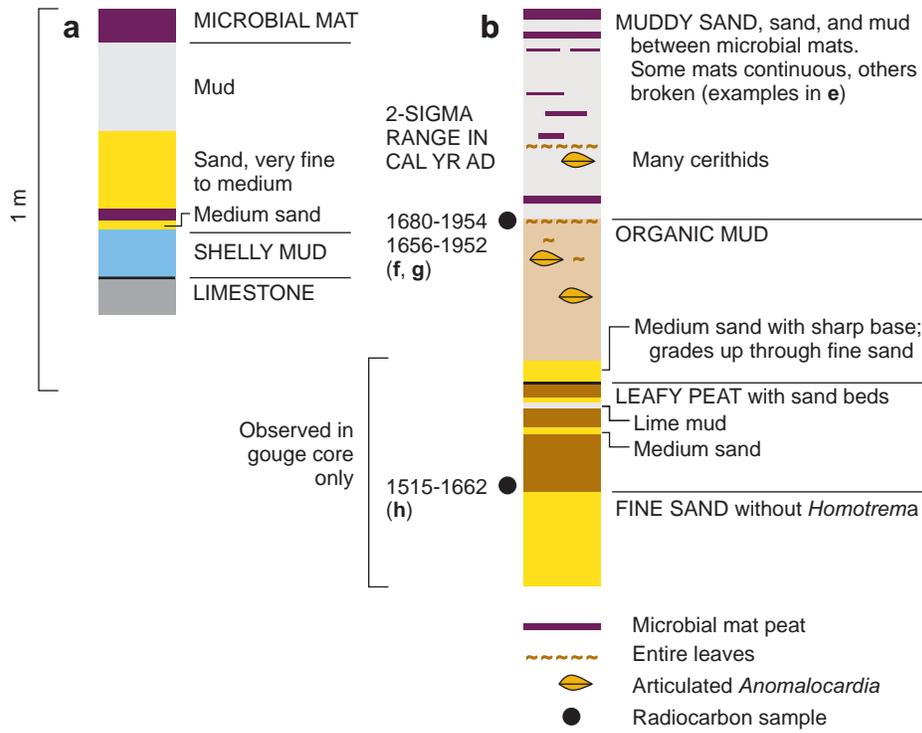
Water on floor of pit

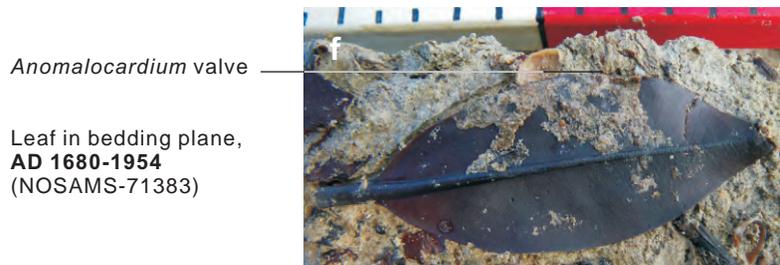
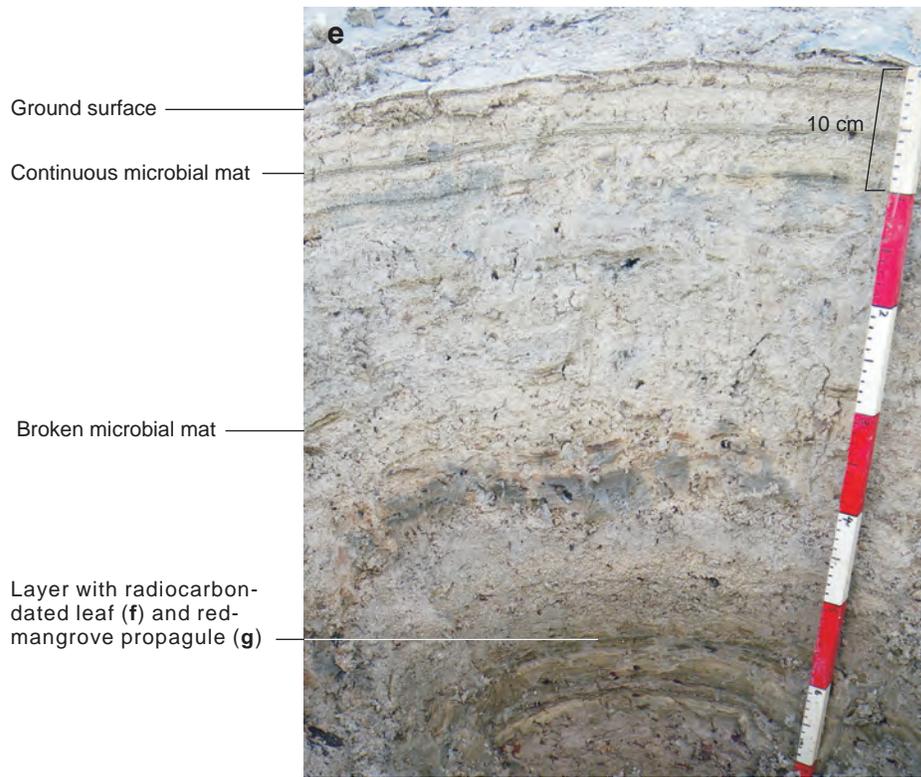
10 cm

Vertical range and proportions of gutter sample in f



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a



b





Mat of reddish-brown mangrove roots. The roots and the person's boots rest on limestone.

Brain coral partly embedded in sandy deposits that overlie the limestone. The lowest 10 cm of these deposits consist of fine to medium sand with cerithid gastropods and disarticulated *Anomalocardia* valves. Above that the sand is fine and molluscs are sparse. All these deposits may be part of the sand-and-shell sheet, but later bioturbation by crabs has disturbed them.