ASAF ASHRAF EN-020

GRADUATE SCHOOL OF OCEANOGRAPHY
UNIVERSITY OF RHODE ISLAND
KINGSTON, RHODE ISLAND, 02881 USA

R/V ENDEAVOR
EN-20 CRUISE REPORT

PROJECT: Tephrochronology of the Lesser Antilles Volcanic Arc

ITINERARY:

	3 April 1978	Depart Narragansett, RI
	9 April 1978	Arrive Pointe-a-pitre, Guadeloupe
	9 April 1978	Depart Pointe-a-Pitre, Guadeloupe
	26 April 1978	Arrive Pointe-a-Pitre, Guadeloupe

23 days at sea.

FUNDING: H. Sigurdsson and R.S.J. Sparks, NSF OCE-77-25789

SCIENTIFIC PARTY:

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CRUISE SYNOPSIS:

EN-20 is the second cruise in our study of volcanism in the Lesser Antilles arc. The previous cruise (GS-7605) was largely devoted to piston-coring in southern and western regions of the arc, whereas the present cruise covered the northern and western regions. The principal objective of these cruises is to obtain a record of explosive volcanism in the Lesser Antilles by piston and gravity coring on the arc flanks and adjacent basins in the Grenada Trough to the west and the Tobago Trough and adjacent Atlantic to the east of the arc.

Piston Coring: The new URI piston coring system with a 1600 kg. core weight was employed as standard equipment on this cruise, after preliminary testing during EN-10. The system proved highly efficient in operation and yielded relatively good penetration and core recovery in view of the coarse nature of the volcanogenic deposits encountered. A total of 54 gravity and piston-cores were attempted on the cruise, yielding a total sediment recovery of 196 m. Average recovery of 36 successful piston-cores was 5.3 m, with maximum recovery of 11.3 m. The location, water depth and recovery of coring stations is given in Table 1.

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Another innovation of the shipboard program was the core splitting, logging and sampling carried out on-board. Such immediate examination of core stratigraphy rapidly established the distribution and nature of the volcanic ash layers in a particular area and proved to be extremely valuable in maximizing ship-time use during the cruise. It was thus possible to make adjustments of the cruise track based on the accumulating core logs. Preliminary biostratigraphic analysis of core-catcher foraminifera during the cruise indicates that several cores penetrated the V-T time zone boundary and thus recovered sediments over 400,000 years old.

Approximately 150 layers of volcanic ash are present in the cores taken on cruise EN-20 and individual cores recovered up to 19 layers. They are principally of two types: thin (1-10 cm) air-fall tephra and thicker volcanic ash-turbidites, up to 4.5 m in thickness. The spatial distribution of these contrasting tephra layers near the arc further confirms the pattern observed in cores from cruise GS-7605: air-fall tephra layers predominate east of the arc (80%) indicating a dispersal pattern largely determined by the high-level (5-17 km) antitrade winds in the region. Three or four of these pale-colored air-fall tephra layers have been correlated from core-to-core over a few hundred km. east of the arc. They are tentatively correlated with land deposits from large explosive eruptions in the volcanic centers in Dominica, Martinique, St. Lucia and Guadeloupe.

Volcanic ash layers recovered in cores west of the arc are, on the other hand, predominantly (75%) ash-turbidites. They are frequently normally graded, contain pumice clasts up to 7 cm in diameter up to 250 km from source and contain charcoal lumps, rip-up clay clasts and other features indicative of turbidite transport. These ash-turbidites can be attributed to pyroclastic flow phases of major explosive eruptions in the arc. The preponderance of ash-turbidites west of the arc, and their scarcity in cores east of the arc, is a puzzling feature. Factors contributing to this asymmetric distribution may be the steep slopes of the western arc flank (9°, vs. 1.5° average for eastern flank) and the prevailing westerly ocean currents in the region.

The most widespread of the ash-turbidites was traced to the island of Dominica. Detailed bathymetric and seismic reflection (3.5 khz) surveys on the western submarine flank of this volcanic island revealed up to 300 m high depositional ridges off the land-based pyroclast flow deposits of the Grand Savane and the Roseau Valley; connecting the subaerial deposits with the submarine ash-turbidite fans. Dredging at 700 m depth on the ridge off Grand Savane recovered incipiently welded pyroclast flow deposit from in situ outcrops analogous to the welded tuff we have studied on land at this locality. This is, to our knowledge, the first clear indication of the occurrence of submarine welded tuffs.

The western submarine flank of the Soufriere volcano of St. Vincent was similarly surveyed by bathymetric and seismic reflection profiling in order to elucidate the mode of transport of submarine pyroclast flows from this volcano, which broke telephone cables here in 1902. Unlike the constructional features on the flank of Dominica, the Soufriere submarine flank is characterized by a deeply incised, barren channel or canyon off the mouth of the Wallibou river. We speculate that these two contrasting features, both associated with pyroclast flow eruptions, may reflect differing discharge rates during eruptions, whth high discharge in the Dominica eruptions, leading to incipient welding and preservation of the pyroclast flow deposits on the volcano's steep submarine flank. We are presenting a paper on these findings at the Toronto meeting of the Geological Society of America in October, 1978.

Seismic profiling: A 3.5 khz seismic reflection system was operated throughout the cruise. The seismic record proved invaluable in identification of sediment types and thus in aiding the selection of coring sites. The seismic record also delineated the trace of the zone of underthrusting of the Atlantic sedimentary pile under the arc off the eastern arc flank. Profiles in northern region of the Grenada Trough, e.g. west of Guadeloupe, reveal common normal faulting of apparently youthful age, striking northerly. The degree of faulting increases westward, where the sedimentary blanket is thin or absent and replaced by a "hard" surface reflector of uneven topography. We speculate that back-arc spreading may be responsible for these features. These tantalizing features were not surveyed further on this cruise, but deserve serious study, as the positive identification of a back-arc spreading center in the Grenada Trough may have a key role in our understanding of the structure of this arc.

Submarine volcanism: Part of the objectives of cruise EN-20 was a study of the growth of a submarine arc volcano. We have been monitoring for some time in evolution of the active basaltic submarine volcano Kick'em-Jenny off Grenada in southern part of the arc. In the last two decades this volcano has had eruptions every other year on average; last in 1977; and has grown in height on average 4.5 m/yr. since observations started in 1962. Kick'em-Jenny is by far the most active volcano in the arc; with the last eruption in 1977. Results of the 1978 bathymetric survey indicate substantial changes since 1976. The crater rim is now at minimum depth of 160 m below sea level; a growth of 25 m since 1976, presumably due to the 1977 eruption. Growth has been effected by lava extrusion. Bottom photography and dredging indicate pillow-lava structures near the crater rim, associated with block-and-talus deposits on the flanks. Lithology of dredge samples is similar to previously recovered rocks from this volcano: amphibole-phyric alkali-olivine basalt. Three camera stations were taken on the volcano, including one in the crater area. Fifteen XBT's were launched in and around the crater. Several recovered a significant temperature rise on the crater floor, 1 to 2°C over ambient, indicating hydrothermal activity in the crater.

ANCILLARY PROJECTS:

a) An XBT transect was carried out for NOAA's Atlantic Environmental Group. Thirteen XBT stations were taken along the transit track on the U.S. continental shelf and rise from 41°10'N to 39°54'N on 4 April 1978. Station information is provided in Table 2. The complete XBT log and original traces are filed with Dr. R.W. Crist of NOAA/Barragansett.

b) Seventeen XBT stations were taken on a section from 32°40'N to 27°20'N for the POLYMODE Local Dynamics Experiment west of Bermuda. Station information is given in Table 3. The station log and original XBT traces are filed with Dr. J. Price, GSO/URI.

c) Four hydrocasts for bacterioplankton sampling were taken on cruise EN-20 for Dr. John Sieburth of GSO/URI. Station information is provided in Table 4.

TABLE 1

EN-20 Core Listing

Core No.		Lat.	Long.	Water Depth (m)	Length (m)
1	G	17°48.4'N	63°2.6'W	676	.34
2	P	17°48.7'N	63°2.2'W	680	3.13
3	P	17°37.9'N	62°48.5'W	585	.46
4	P	15°49.7'N	62°1.8'W	1420	4.43
5	P	15°52.6'N	62°2.7'W	1476	6.43
6	P	15°25.3'N	62°34.8'W	2298	6.55
7	P	15°47.3'N	62°41.1'W	1955	1.20
8	P	16°17.9'N	62°56.4'W	1453	5.83
9	P	16°33.4'N	63°13.0'W	1450	5.40
10	P	17°22.2'N	63°3.3'W	685	3.93
11	P	17°26.8'W	62°40.2'W	660	2.45
12	G	17°33.7'N	62°35.0'W	690	.39
13	G	17°21.0'N	62°28.5'W	680	.35
14	G	17°18.1'N	62°21.6'W	630	.24
15	G	17°57'N	62°13.3'W	563	.35
16	P	16°50.3'N	61°56.3'W	737	2.87
17	G	17°5.9'N	61°21.6'W	540	no core
18	P	17°27.0'N	62°2.0'W	4030	5.04
19	P	17°2.6'N	60°9.1'W	4800	3.86
20	G	16°2.8'N	60°45.1"W	775	no core
21	G	16°4.0'N	60°43.6'W	785	no core
22	G	16°43.7'N	58°23.5'W	3750	.54
23	P	16°43.7'N	58°23.5'W	3875	5.80
24	G	16°34.5'N	57°43.6'W	4030	no core
25	P	16°21.1'N	57°9.3'W	4100	no core
26	G	15°53.9'N	57°4.9'W	5360	.32
27	G	15°33.2'N	58°1.4'W	5540	.48
28	P	15°22.6'N	58°18.2'W	4157	3.94
29	P	15°2.2'N	58°43.5'W	3565	9.01
30	P	14°39.6'N	60°23.7'W	2843	8.13
31	P	14°14.8'N	60°8.2'W	2360	6.82
32	P	14°30.0'N	61°27.1'W	2765	3.85
33	P	14°32.7'N	61°22.4'W	2696	2.12
34	P	14°56.6'N	61°56.4'W	2740	1.59
35	P	15°18.8'N	61°57.1'W	2552	5.43
36	P	15°6.6'N	62°13.1'W	2736	5.97
37	P	14°36.6'N	62°06.0'W	2888	8.91
38	P	14°19.2'N	62°09.2'W	2941	4.20
39	P	14°15.6'N	62°15.6'W	2917	5.95
40	G	14°15.1'N	62°27.7'W	2695	.52
41	P	13°57.8'N	63°11.3'W	1090	8.18
42	P	13°5.2'N	62°41.6'W	2985	3.95
43	P	12°57.2'N	62°22.6'W	3005	5.95
44	P	13°11.0'N	62°2.1'W	2985	6.01
45	P	13°39.1'N	61°46.3'W	2961	2.18
46	P	13°47.0'N	61°29.0'W	2924	7.15
47	P	13°48.0'N	60°31.5'W	1475	7.55
48	P	12°50.2'N	60°14.9'W	2437	5.38

49	P	12°26.3'N	60°26.6'W	2447	10.86
50	P	12°27.2'N	61°57.5'W	2795	11.31
51	Dredge	12°18.0'N	61°38.2'W	175	
52	G	13°26.2'N	61°27.2'W	2719	no core
53	G	13°22.5'N	61°27.7'W	2685	no core
54	G	15°12.6'N	61°40.7'W	2518	.31
55	G	15°12.8'N	61°40.2'W	2518	.25
56	Dredge	15°25.6'N	61°29.8'W	986	

Total Core: 195.82 m

TABLE 2

A.E.G. (NOAA) XBT LOG. 4-LV-1978

Station	Lat.	Long.	Time	T_s	S.Sal #
AEG-1	41°09.9'N	71°16.0'W	0107Z	4.4°C	865
AEG-2	41°00.5'N	71°10.2'W	0150Z	3.9°C	866
AEG-3	40°50'3'N	71°05.0'W	0236Z	3.4°C	867
AEG-4	40°41.8'N	71°00.7'W	0321Z	4.1°C	868
AEG-5	40°32.4'N	70°55.4'W	0407Z	4.8°C	869
AEG-6	40°23.2'N	70°51.3'W	0449Z	4.7°C	870
		TEST CANNISTER CHECK	0508Z		
		-1.1°C READS -1.15°C			
		34.4°C READS 34.5°C			
AEG-7	40°17.8'N	70°49.0'W	0512Z	5.4°C	871
AEG-8	40°12.9'N	70°46.1'W	0535Z	5.3°C	872
AEG-9	40°09.2'N	70°44.9'W	0550Z	5.05°C	873
		C/C to AVOID DRAGGER	0555Z		
		WILL RESUME CSE WHEN CLEAR			
AEG-10	NOT TAKEN DUE TO TRAFFIC IN VICINITY				
AEG-11	39°59.9'N	70°38.6'W	0640Z	6.55°C	875
AEG-12	39°55.0'N	70°36.2'W	0703Z	6.8°C	876
AEG-13	39°53.6'N	70°35.5'W	0710Z	6.3°C	877

STATION #13 WAS TAKEN AS CLOSE TO #12 AS POSSIBLE TO TEST THE REPEATABILITY OF MEASUREMENT.

TABLE 3

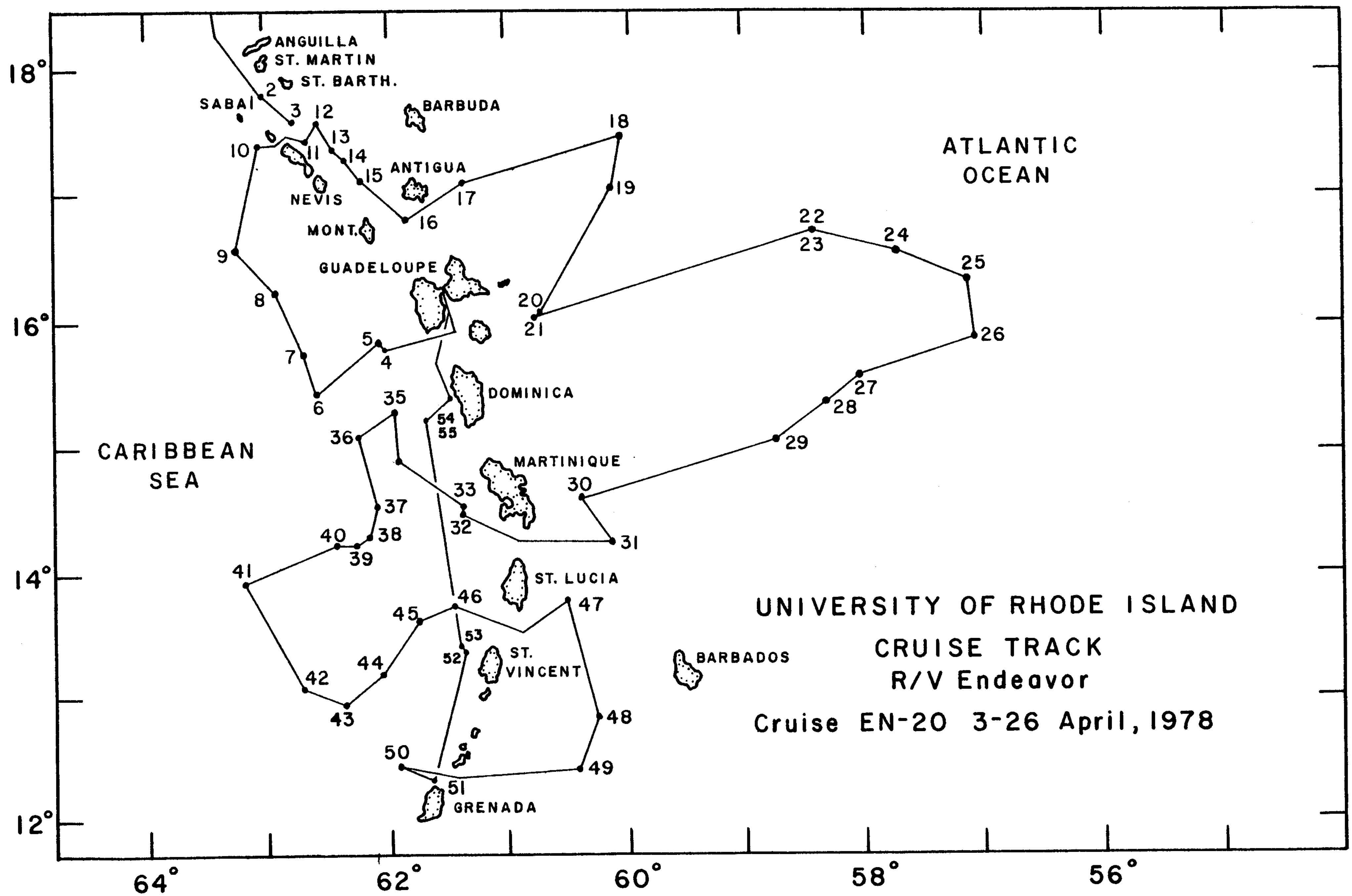
POLYMODE XBT STATION DATA
5-IV-1978 to 6-IV-1978

Station	Latitude	Longitude	Time	T_s	Depth 15°
P1	32°40'N	67°02'W	1545Z	19.8°C	610 m
P2	32°20.9'N	66°54.6'W	1711Z	-	625 m
P3	32°00'N	66°46.3'W	1848Z	20.0°C	585 m
P4	31°40'N	66°38.4'W	2017Z	19.5°C	580 m
P5	31°24'N	66°35'W	2147Z	19.8°C	530 m
P6	31°00'N	66°27.5'W	2338Z	19.7°C	515 m
P7	30°40'N	66°18.9'W	0109Z	19.5°C	508 m
P8	30°20'N	66°11.3'W	0239Z	19.6°C	485 m
P9	30°00'N	66°02.6'W	0409Z	19.4°C	508 m
P10	29°40'N	66°54.3'W	0542Z	19.3°C	535 m
P11	29°20'N	65°45.9'W	0714Z	19.5°C	568 m
P12	29°00.6'N	65°38.2'W	0843Z	22.0°C	575 m
P13	28°40.0'N	65°26.0'W	1122Z	21.2°C	605 m
P14	28°20.0'N	65°18.2'W	1254Z	22.1°C	568 m
P15	28°00.0'N	65°09.0'W	1428Z	22.0°C	586 m
P16	Failed				
P16A	27°37.8'N	65°01.0'W	1607Z	22.2°C	600 m
P17	27°20.0'N	64°58.4'W	1729Z	22.2°C	610 m

TABLE 4

EN-20 Hydrocast Stations (Sieburth)

	Latitude	Longitude	Time	Date	Surface Temp.	100 M Temp.
S-1	29°00.3'N	65°35.5'W	0915Z	6-IV-78	21.9°C	20.2°C
S-2	22°00.0'N	64°07.0'W	1646Z	7-IV-78	25.5°C	
S-3	12°26.4'N	60°26.3'W	1122Z	22-IV-78		
S-4	12°28.0'N	61°58.3'W	2224Z	22-IV-78		


UNIVERSITY OF RHODE ISLAND
CRUISE TRACK
R/V Endeavor
Cruise EN-20 3-26 April, 1978
ATLANTIC OCEAN
CARIBBEAN SEA
ANGUILLA
ST. MARTIN
ST. BARTH.
SABA
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ANTIGUA
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MONT.
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