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Analytical results for 38 water samples from a hydrogeochemical survey of the U.S. Virgin Islands

By

J.B. McHugh* and R.E. Tucker*

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*U.S. Geological Survey, DFC, Box 25046, MS 973, Denver, CO 80225

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CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

A hydrogeochemical study was conducted in the U.S. Virgin Islands on the islands of St. John and St. Croix. Thirty-eight water samples were collected, twenty-nine samples from St. John and nine samples from St. Croix. The nine samples from St. Croix were collected in November 1984. The samples from St. John were collected in January 1985 except for the last seven samples which were collected in August 1986.

The purpose of the study was to examine the concentration of metals and anions in water to determine the hydrogeochemical characteristics associated with mineralization on St. John and St. Croix Islands (Tucker and others, 1985; Alminas and Tucker, 1987; Tucker, 1987). The samples were analyzed for 15 metal ions, silica, and five anions along with pH and specific conductance. The study was funded by the USGS Virgin Islands project.

STUDY AREA

The U.S. Virgin Islands are located in the Greater Antilles Island arc some 40 mi east of Puerto Rico (fig. 1). The major islands include St. Thomas, St. John, and St. Croix. There are about 50 smaller islands in the study area concentrated near St. Thomas and St. John.

St. John is 7 mi long, on the average is 3 mi wide, and contains some 12,000 acres. The topography is mountainous with the highest elevation of 1,277 ft on Bordeaux Mountain. The island has a very irregular coastline with many bays and offshore islets. St. Croix, the largest of the U.S. Virgin Islands, is 22 mi long and 6 mi wide with 54,000 acres. St. Croix is characterized by regular coastline and two adjacent islands. The topography is more subdued with the highest point of 1,165 ft on Mt. Eagle. Streams on these two islands are intermittent and discharge into the sea.

The climate in the Virgin Islands is maritime tropical. The average annual rainfall at higher elevations is 50-60 in and at lower elevations 20-30 in. There is no well-defined wet or dry season. The temperature is generally constant between 80 and 85°F.

The vegetation is generally not native to the islands and consists of thorny brush and Hurricane grass in the formerly cleared areas. The uncleared portions of the more mountainous areas are covered by dense tropical forest with a few large trees and a dense undergrowth of brush and vines.

SAMPLE COLLECTION

Thirty-eight water samples were collected from the study area. At each site, a 60-ml sample was filtered through a 0.45-μm membrane filter into an acid-rinsed polyethylene bottle, and then acidified with reagent grade concentrated nitric acid to a pH of less than 2. A 500-ml untreated sample was also collected in a clean polyethylene bottle.

ANALYTICAL METHODS

Water temperature and pH were measured at the sample site. All other analyses were completed at the U.S. Geological Survey laboratory in Denver, Colorado.

Calcium, magnesium, sodium, potassium, lithium, silica, zinc, copper, molybdenum, silver, arsenic, vanadium, iron, manganese, and aluminum were determined using the filtered-acidified sample. Alkalinity, sulfate,

chloride, fluoride, nitrate, uranium, and specific conductance were determined using the untreated sample. Alkalinity measures the total acid-neutralizable constituents in water and is generally due to the presence of carbonate and bicarbonate ions. A complete list of analytical methods used and a reference for each are listed in table 1.

RESULTS

Figures 2 and 3 are maps showing the location of each sample on the islands of St. Croix and St. John respectively. All the samples were collected from springs or streams except as noted. Sample numbers SC01, SJ75, SJ86, SJ87, and SJ88 are estuary water samples. Sample numbers SC06, SJ64, SJ81, SJ82, and SJ83 are rainwater samples. The rainwaters were collected off of building roofs.

The analytical results of the 23 constituents that were determined for these samples are shown in table 2 along with the latitude and longitude for each sample location. Duplicate samples were collected at sites SJ67-68, SJ72-73, and SJ82-83. The results of the charge balance shown in table 2 for the 38 samples show good accuracy of analyses. Ionic solutions are electrically neutral. By comparing the sum of the charges for cations against anions, accuracy of analyses can be checked. Twenty-one of the samples are within 5 percent, fifteen samples are between 5-10 percent, and two samples are between 10-15 percent of electrical neutrality.

The high salt content of the estuary water samples from the sea causes interferences in the analytical procedure which give high copper, silver, and molybdenum values.

REFERENCES CITED

Alminas, H.V., and Tucker, R.E., 1987, Lead, tin, and precious-metals mineralization in the U.S. Virgin Islands: Society of Mining Engineers annual meeting, preprint number 87-108.

Fishman, J.J., and Pyen, G., 1979, Determination of selected anions in water by ion chromatography: U.S. Geological Survey Water Resources Investigations 79-101, 30 p.

Orion Research, Inc., 1978, Analytical methods guide, 9th ed.: Cambridge, Massachusetts, 48 p.

Perkin-Elmer Corporation, 1976, Analytical methods for atomic-absorption spectrophotometry: Norwalk, Connecticut, Perkin-Elmer Corporation, 586 p.

_____1977, Analytical methods for atomic-absorption spectrophotometry, using the HGA graphite furnace: Norwalk, Connecticut, Perkin-Elmer Corporation, 208 p.

Scintrex Corporation, 1979, UA-3 Uranium Analyzer: Toronto, Canada, 45 p.

Skougstad, M.W., Fishman, M.J., Fruedmann, L.C., Erdmann, D.E., and Duncan, S.S., 1979, Methods for determination of inorganic substances in water and fluvial sediments: Techniques of Water Resources Investigations of the U.S. Geological Survey, chapter A1, 26 p.

Tucker, R.E., 1987, A geochemical study of St. John, U.S. Virgin Islands: Colorado School of Mines, Ph.D. dissertation, 405 p.

Tucker, R.E., Alminas, H.V., and Hopkins, R.T., 1985, Geochemical evidence for metallization on St. Thomas and St. John, U.S. Virgin Islands: U.S. Geological Survey Open-File Report 85-297, 46 p.

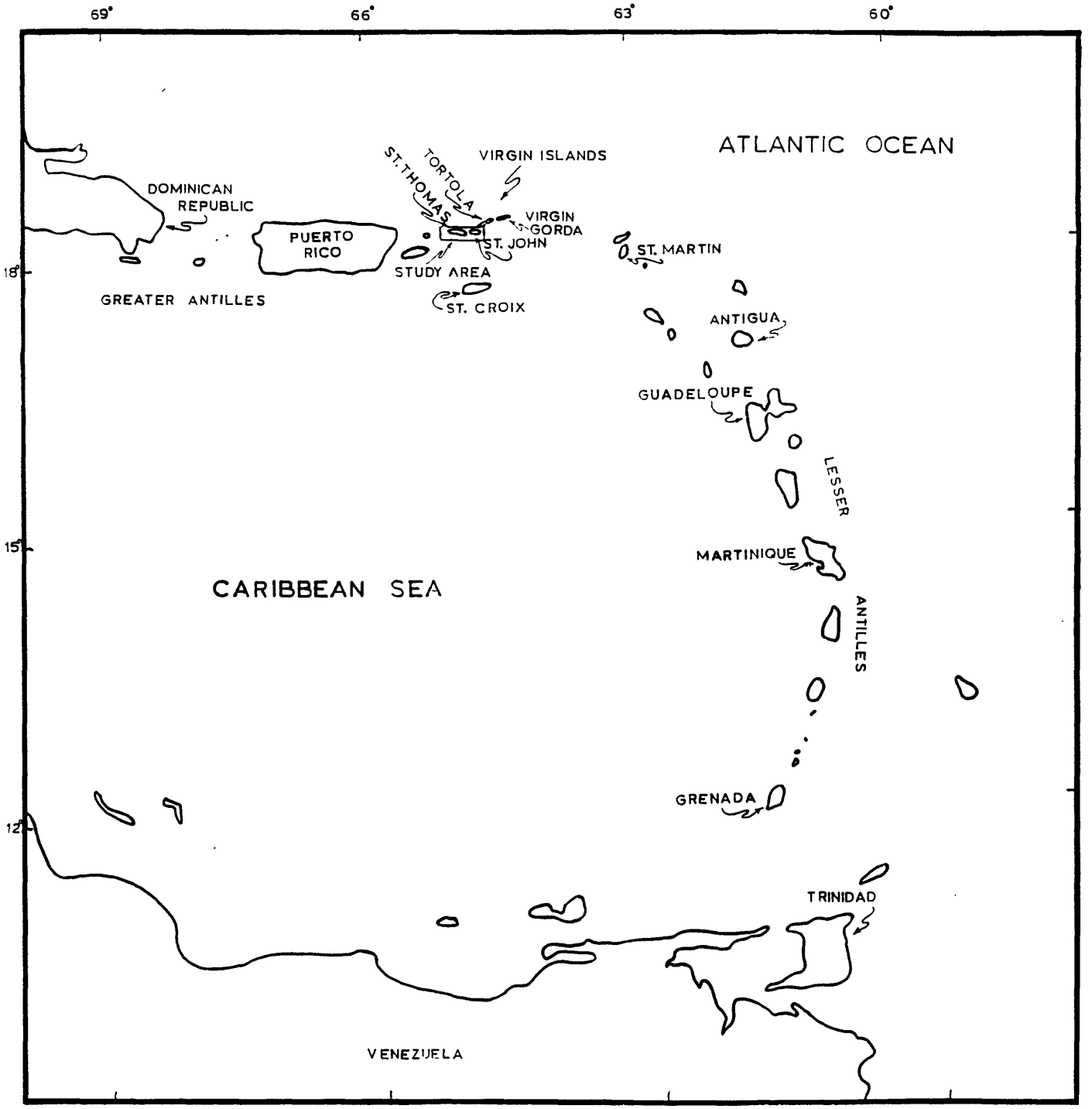

Figure 1. Index map of the study area.

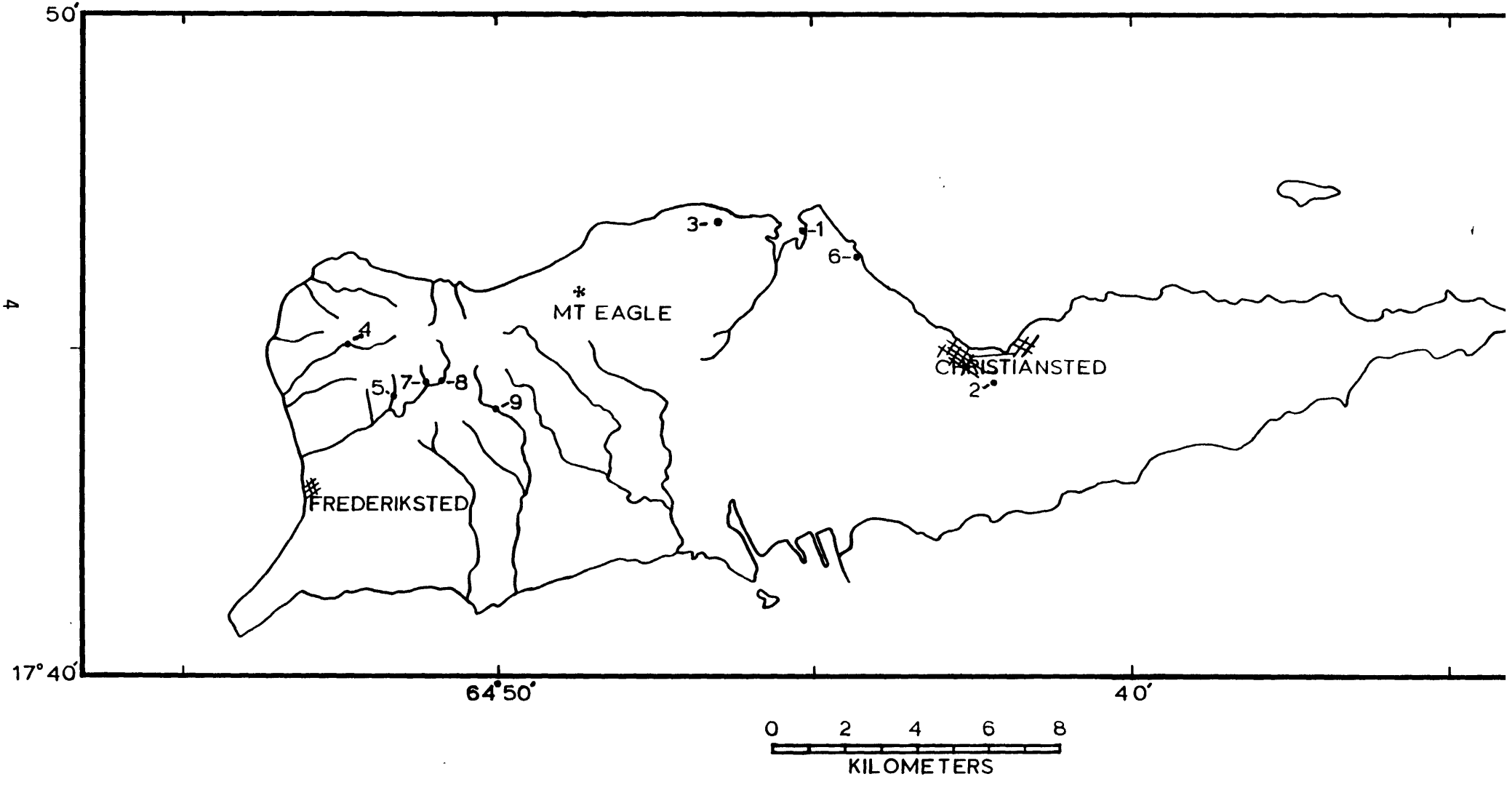

Figure 2. Sample location map of St. Croix Island.

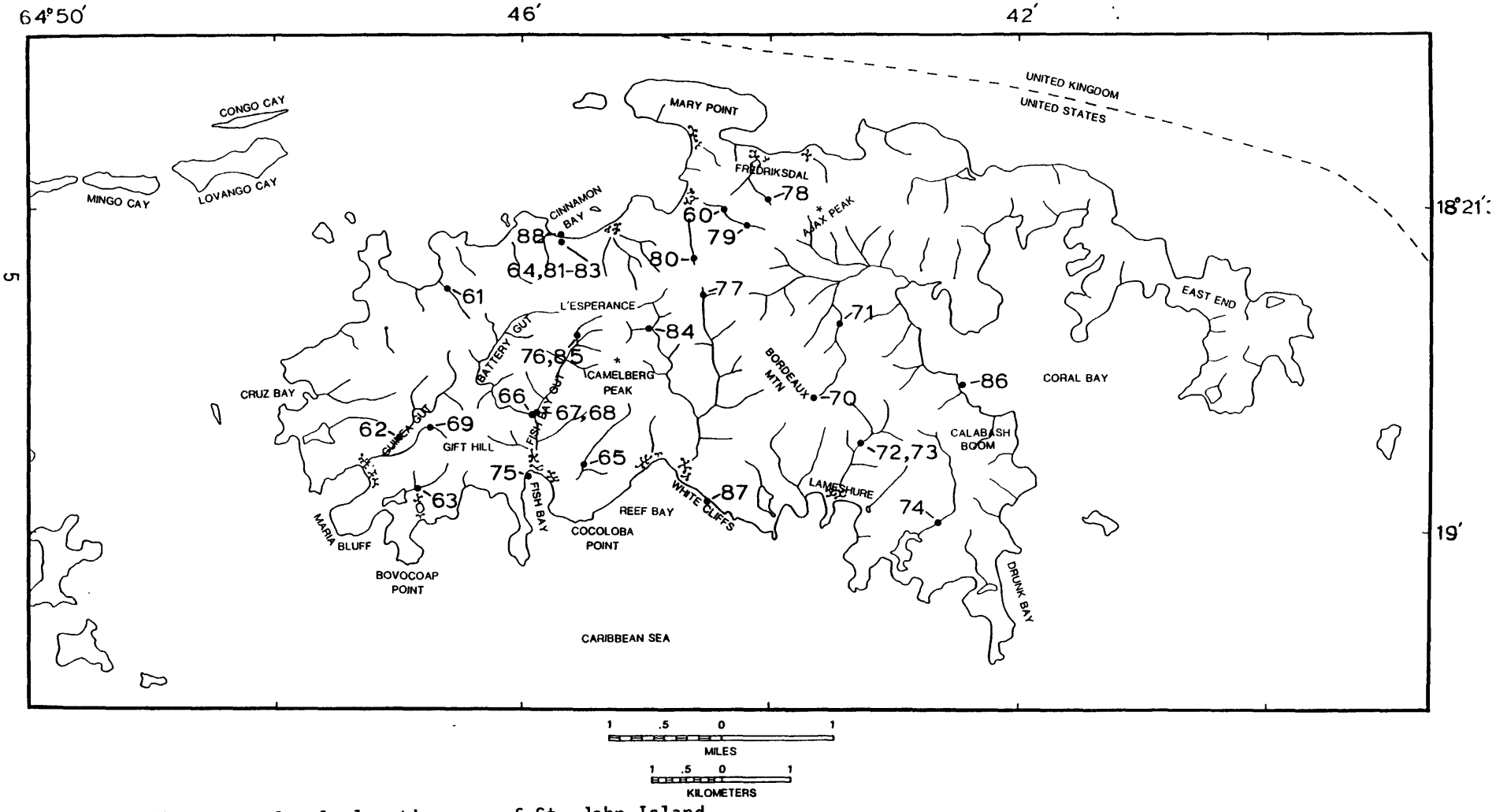

Figure 3. Sample location map of St. John Island.

TABLE 1.--Analytical methods used for water analyses, U.S. Virgin Islands

Constituents	Method	Reference
Alkalinity	Gran's plot potentiometric titration	Orion Research, Inc. (1978).
Sulfate, chloride, and fluoride	Ion chromatography	Fishman and Pyen (1979).
Uranium	Laser-excited fluorescence	Scintrex Corp. (1979).
Specific conductance	Conductivity bridge	Skougstand et al. (1979), p. 545.
Calcium, magnesium, sodium, potassium, silica, lithium, aluminum, iron, manganese, and zinc	Flame atomic-absorption spectrophotometry	Perkin-Elmer Corp. (1976).
Arsenic, silver, vanadium, copper, and molybdenum	Flameless atomic-absorption spectrophotometry	Perkin-Elmer Corp. (1977).

Table 2. CHEMICAL ANALYSES FOR 38 WATER SAMPLES FROM THE U.S. VIRGIN ISLANDS

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	LATITUDE	LONGITUD	CA(MG/L)	MG(MG/L)	NA(MG/L)	K(MG/L)	LI(UG/L)	SIO2(MG/	ALK(MG/L
SC01	17 46 43	64 45 10	580.0	1,040.0	10,000.0	390.00	190	1.7	143.0
SC02	17 44 27	64 42 4	37.0	17.0	60.0	7.20	<4	28.0	208.0
SC03	17 46 53	64 46 34	70.0	27.0	140.0	3.80	<4	22.0	295.0
SC04	17 45 3	64 52 20	90.0	18.0	55.0	2.50	<4	23.0	240.0
SC05	17 44 15	64 51 41	115.0	18.0	55.0	2.30	<4	27.0	240.0
SC06	17 46 10	64 44 15	2.7	2.2	22.0	.90	<4	<1.0	4.9
SC07	17 44 25	64 51 9	82.0	25.0	66.0	2.30	<4	23.0	315.0
SC08	17 44 23	64 50 54	102.0	26.0	63.0	1.40	<4	24.0	394.0
SC09	17 44 7	64 50 1	90.0	25.0	93.0	1.30	<4	25.0	240.0
SJ60	18 21 29	64 44 23	15.0	11.0	150.0	4.20	<4	27.0	177.0
SJ61	18 20 54	64 46 37	122.0	51.0	140.0	3.20	<4	41.0	396.0
SJ62	18 19 46	64 47 0	70.0	48.0	300.0	3.10	<4	27.0	473.0
SJ63	18 19 22	64 46 52	103.0	46.0	320.0	7.70	<4	26.0	628.0
SJ64	18 21 14	64 45 41	2.6	1.9	18.0	1.30	<4	<1.0	5.5
SJ65	18 19 32	64 45 31	71.0	44.0	180.0	7.70	<4	20.0	377.0
SJ66	18 19 55	64 45 57	46.0	31.0	300.0	4.20	<4	25.0	526.0
SJ67	18 19 55	64 45 54	52.0	41.0	220.0	3.60	<4	29.0	483.0
SJ68	18 19 55	64 45 54	52.0	41.0	220.0	3.70	<4	29.0	416.0
SJ69	18 19 51	64 46 44	118.0	84.0	310.0	1.10	<4	39.0	586.0
SJ70	18 20 4	64 43 38	2.9	4.6	57.0	1.30	<4	26.0	9.0
SJ71	18 20 38	64 43 26	6.8	7.9	66.0	3.00	<4	20.0	35.0
SJ72	18 19 43	64 43 15	53.0	66.0	560.0	6.90	<4	27.0	365.0
SJ73	18 19 43	64 43 15	53.0	66.0	560.0	6.80	<4	27.0	357.0
SJ74	18 19 17	64 42 37	5.1	5.8	68.0	3.90	<4	24.0	75.0
SJ75	18 19 26	64 45 58	610.0	1,120.0	11,000.0	420.00	200	1.5	143.0
SJ76	18 20 32	64 45 34	83.0	50.0	360.0	8.40	<4	40.0	643.0
SJ77	18 20 49	64 44 33	41.0	39.0	220.0	3.60	<4	35.0	452.0
SJ78	18 21 34	64 44 2	11.0	5.1	32.0	5.20	<4	23.0	78.0
SJ79	18 21 22	64 44 11	11.0	5.8	36.0	3.30	<4	21.0	65.0
SJ80	18 21 7	64 44 38	15.0	16.0	180.0	5.20	<4	30.0	213.0
SJ81	18 21 14	64 45 41	1.2	.6	3.5	.40	<4	<1.0	3.9
SJ82	18 21 16	64 45 41	.5	.1	2.3	.92	<2	1.0	2.0
SJ83	18 21 16	64 45 41	.6	.2	5.3	.84	<2	<1.0	4.0
SJ84	18 20 36	64 44 58	79.0	43.0	210.0	3.30	<2	33.0	680.0
SJ85	18 20 31	64 45 34	79.0	44.0	280.0	5.50	<2	40.0	707.0
SJ86	18 20 18	64 42 27	410.0	1,060.0	11,400.0	440.00	155	2.0	147.0
SJ87	18 19 15	64 45 30	410.0	1,060.0	11,400.0	450.00	155	2.0	134.0
SJ88	18 21 18	64 45 40	410.0	1,060.0	11,200.0	440.00	155	2.0	148.0

Table 2. CHEMICAL ANALYSES FOR 38 WATER SAMPLES FROM THE U.S. VIRGIN ISLANDS--Continued

Sample	SO4(MG/L	CL(MG/L)	F(MG/L)	NO3(MG/L	ZN(UG/L)	CU(UG/L)	MO(UG/L)	AG(UG/L)
SC01	2,070.0	20,200.0	9.00	<.1	66	45.0	5.5	1.60
SC02	11.0	75.0	<.01	<.1	10	5.4	<1.0	<.02
SC03	31.0	145.0	<.01	<.1	9	2.0	<1.0	<.02
SC04	10.0	74.0	.22	<.1	10	1.5	<1.0	<.02
SC05	16.0	102.0	<.01	<.1	11	1.1	<1.0	<.02
SC06	5.0	36.0	.03	<.1	17	1.0	<1.0	<.02
SC07	9.0	75.0	<.01	<.1	8	1.2	<1.0	<.02
SC08	17.0	77.0	<.01	<.1	10	1.4	<1.0	.03
SC09	30.0	139.0	3.00	<.1	7	1.2	<1.0	<.02
SJ60	18.0	150.0	<.01	<.1	8	2.2	<1.0	<.02
SJ61	29.0	248.0	<.01	<.1	10	1.9	<1.0	<.02
SJ62	31.0	338.0	.46	<.1	6	2.0	<1.0	.02
SJ63	93.0	359.0	2.00	<.1	6	3.2	<1.0	.06
SJ64	4.0	35.0	.04	<.1	8	1.0	<1.0	<.02
SJ65	27.0	277.0	10.00	<.1	6	4.5	<1.0	<.02
SJ66	20.0	285.0	.40	<.1	5	2.0	<1.0	<.02
SJ67	16.0	250.0	<.01	<.1	4	1.9	<1.0	<.02
SJ68	16.0	242.0	.40	<.1	4	1.4	<1.0	<.02
SJ69	66.0	409.0	.52	<.1	11	2.5	<1.0	.02
SJ70	8.0	80.0	.08	<.1	17	10.0	<1.0	.03
SJ71	12.0	98.0	.12	<.1	18	16.0	<1.0	.06
SJ72	111.0	827.0	.85	<.1	9	3.0	<1.0	.05
SJ73	114.0	706.0	2.00	<.1	7	2.3	<1.0	.05
SJ74	6.0	76.0	.13	<.1	6	2.3	<1.0	<.02
SJ75	2,300.0	21,400.0	6.00	<.1	25	45.0	5.5	1.70
SJ76	29.0	343.0	.70	<.1	5	2.0	<1.0	.03
SJ77	36.0	195.0	<.01	<.1	9	<1.0	<1.0	<.02
SJ78	4.0	27.0	.07	<.1	6	5.0	<1.0	.03
SJ79	2.0	46.0	.09	<.1	4	3.0	<1.0	.02
SJ80	29.0	199.0	<.01	<.1	4	1.5	<1.0	.02
SJ81	1.0	6.0	<.01	<.1	3	<1.0	<1.0	<.02
SJ82	.6	2.9	.02	<.1	120	2.0	<1.0	<.02
SJ83	2.0	5.8	<.01	.4	80	7.2	1.5	<.02
SJ84	13.0	270.0	.20	<.1	26	1.6	<1.0	<.02
SJ85	17.0	315.0	.30	<.1	22	1.5	1.2	<.02
SJ86	2,100.0	21,600.0	13.00	<.1	60	20.0	16.0	2.40
SJ87	2,000.0	21,900.0	12.00	<.1	35	20.0	17.0	2.40
SJ88	1,900.0	21,300.0	12.00	<.1	40	20.0	16.0	2.40