

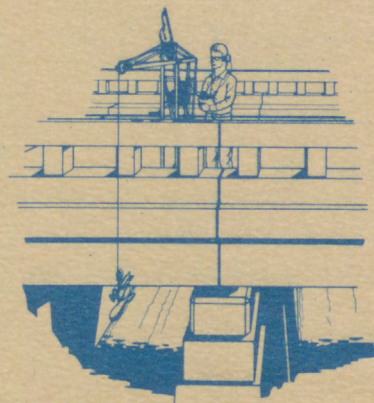
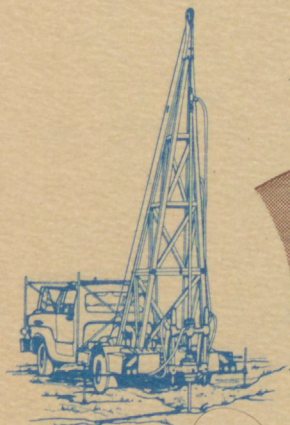
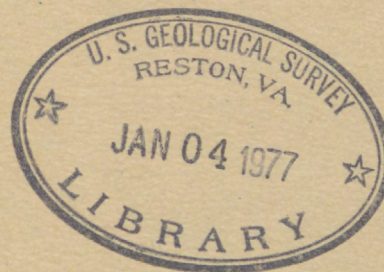
C. 2 in process

RECONNAISSANCE WATER SAMPLING FOR RADIUM - 226 IN CENTRAL AND NORTHERN FLORIDA, DECEMBER 1974 - MARCH 1976

(200)

WRI

no. 76-103



U.S. GEOLOGICAL SURVEY
Water-Resources Investigations 76-103



SAT 75

Prepared in cooperation with
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SUWANNEE RIVER WATER MANAGEMENT DISTRICT
and
FLORIDA STATE DEPARTMENT OF ENVIRONMENTAL REGULATION



RECONNAISSANCE WATER SAMPLING FOR
RADIUM-226 IN CENTRAL AND NORTHERN
FLORIDA, DECEMBER 1974-MARCH 1976
by

G. A. Irwin and C. B. Hutchinson

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations 76-103

Prepared in cooperation with
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SUWANNEE RIVER WATER MANAGEMENT DISTRICT
and
FLORIDA STATE DEPARTMENT OF ENVIRONMENTAL REGULATION

October 1976

UNITED STATES DEPARTMENT OF THE INTERIOR

Thomas S. Kleppe, Secretary

GEOLOGICAL SURVEY

V. E. McKelvey, Director

For additional information write to:

U.S. Geological Survey
325 John Knox Road
Suite F-240
Tallahassee, Florida 32303

CONTENTS

	Page
Abstract.....	1
Introduction.....	1
Methods.....	3
Results.....	3
Summary and conclusions.....	15
References cited.....	16

ILLUSTRATION

Figure	Page
1.--Map showing areas selected for analysis of radium-226 in water.....	2

TABLES

Table	Page
1.--Summary of radium-226 data from selected sites in Polk, DeSoto, Manatee, Hardee, and Hillsborough Counties, December 1974-March 1976 (filtered, unacidified water samples).....	4
2.--Summary of radium-226 data from selected sites in Suwannee, Columbia, Hamilton, Polk, DeSoto, Hillsborough, Hardee and Manatee Counties Florida, December 1974-March 1976 (filtered, acidified with 10 milliliters of 6 normal nitric acid per gallon of water samples).....	12
3.--Results of radium-226 analyses of split samples using two different preanalysis procedures.....	17

For use of those readers who may prefer to use metric units rather than English units, the conversion factor for the term used in this report is listed below:

<u>English</u>	<u>Multiply by</u>	<u>Metric</u>
ft (foot)	0.3048	m (meter)

RECONNAISSANCE WATER SAMPLING FOR RADIUM-226
IN CENTRAL AND NORTHERN FLORIDA, DECEMBER 1974-MARCH 1976

By
G. A. Irwin and C. B. Hutchinson

ABSTRACT

Analyses of 115 water samples collected from December 1974 through March 1976 in eight Florida Counties indicated that 22 samples (19 percent) had radium-226 activities equal to or in excess of 3 picocuries per liter, the concentration limit recommended for drinking water by the U.S. Public Health Service. The maximum radium-226 activity was 90 picocuries per liter in water from a shallow well in Polk County.

The sampling reconnaissance was generally limited to areas of active phosphate mining and areas of undisturbed phosphate deposits. Because of this it is not known if high radium-226 activities are also present elsewhere in the State where there are no phosphate deposits.

INTRODUCTION

According to EPA (Environmental Protection Agency, 1974), radium-226 activities of some waters in Polk County exceed the drinking water limit of 3 pCi/l (picocuries per liter) recommended by the U.S. Public Health Service (U.S. Public Health Service, 1962). The report concluded that the high activities of radium-226 might be the result of phosphate mining operations and suggested that additional studies be made.

As a result of the EPA report (1974), Governor Reuben O'D. Askew requested that a Task Force of Federal, State, and local agencies be formed to conduct a second reconnaissance study. The Task Force was composed mainly of representatives from the Southwest Florida Water Management District, the Suwannee River Water Management District, the Florida State Department of Environmental Regulation and the U.S. Geological Survey. This cooperative reconnaissance water sampling was conducted by these agencies from December 1974 through March 1976.

Water samples were collected for radium-226 analysis at selected sites in Hamilton, Suwannee, Columbia, Hillsborough, Polk, Hardee, Manatee, and DeSoto Counties (fig. 1). Samples were collected mainly in areas of active and potential phosphate mining. The primary emphasis of the reconnaissance was to sample ground water from the shallow sand

aquifer and from both the upper and lower parts of the artesian Floridan aquifer. Some surface-water samples were collected, mainly in the Peace River drainage basin in southwest Florida. In all, 115 water samples were analyzed for radium-226.

METHODS

Water samples collected during this reconnaissance were analyzed by the U.S. Geological Survey in Denver, Colorado, using the Radon emanation analytical method (Thatcher and others, written commun., 1976). Although the same analytical method was used to analyze for the radium-226 in all samples, two different preanalysis sample treatments were used. Seventy-nine of the samples were filtered through a 0.45 micrometer membrane in the laboratory and analyzed with no additional treatment. Thirty-six of the samples were acidified prior to analysis with 10 milliliters of 6-normal nitric acid per gallon of sample. After acidification the samples were mixed, digested at room temperature for 24 hours, then filtered through a 0.45 micrometer membrane, for subsequent analysis. This preanalysis treatment (acidification and filtration), requested by the Department of Environmental Regulation, is not a technique endorsed by the U.S. Geological Survey.

RESULTS

Radium-226 analyses of 79 untreated, filtered, unacidified ground- and surface-water samples collected in Polk, Hillsborough, DeSoto, Manatee, and Hardee Counties are listed in table 1. The minimum activity detected was 0.05 pCi/l in a U.S. Geological Survey monitor well in the shallow-sand aquifer in northern Hardee County. The maximum activity was 90 pCi/l, occurring in a water sample collected in March 1976 from a shallow well in Polk County. A sample collected in February 1976 from this same well had a radium-226 activity of 22 pCi/l.

Radium-226 activity exceeding 3 pCi/l was detected in water from all aquifers from wells ranging in depth from 17 to 2,788 ft (7 to 850 m). Radium-226 activity was less than 3 pCi/l in all surface-water samples, except a sample from a slime pit.

Of the 77 sites sampled for radium-226 in central Florida, water from 16 sites (21 percent) did not meet the drinking water standards of the U.S. Public Health Service. Water from the shallow-sand aquifer had both the highest and lowest radium-226 activities, and water from 6 of 44 sites (14 percent) exceeded 3 pCi/l. Water from 5 of the 18 wells (28 percent) tapping the upper part of the Floridan aquifer, and from 1 of 11 wells (9 percent) tapping the lower part of the Floridan aquifer

Table 1.--Summary of radium-226 data from selected sites in Polk, Hardee, DeSoto, Manatee, and Hillsborough Counties, December 1974-March 1976. (Filtered, unacidified water samples.)

Symbols have been omitted from the latitude and longitude coordinates. Latitude 274504 should read 27°45'04" and longitude 814656 should read 81°46'56".

Latitude	Longitude	County	Well Depth		Date of Collection	Radium 226 (PiC/1)	Aquifer ^{2/}	Remarks
			Total (feet)	Casing (feet)				
274504	814656	Polk	Peace River ^{1/} at Ft. Meade		12/06/74	0.12		
275219	821241	Hillsborough	Alafia River ^{1/} at Lithia		do.	.06		
275158	821357	do.	Lithia Springs ^{1/} at Lithia		do.	.68		
271303	815037	DeSoto	320	141	12/20/74	7.9	UF	Municipal supply for the city of Arcadia.
272954	814930	Hardee	220	84	12/03/74	1.5	UF	Near future phosphate mining area.
272954	814930	do.	35	21	do.	.20	SA	Do.
273001	820816	Manatee	1225	750	01/29/75	4.7	LF	Do.
273002	820817	do.	195	130	do.	.54	LF	Do.
273008	820816	do.	30	20	do.	.20	SA	Do.
273008	820817	do.	650	500	do.	1.4	LF	Do.
273516	814628	Hardee	17	12	03/12/75	.24	SA	USGS monitor well

^{1/} Duplicate Samples (See Table 3).

^{2/} See page 10 for explanation

Table 1.--Summary of radium-226 data from selected sites in Polk, Hardee, DeSoto, Manatee, and Hillsborough Counties, December 1974-March 1976. (Filtered, unacidified water samples.)--Continued

Latitude	Longitude	County	Well Depth Total (feet)	Casing (feet)	Date of Collection	Radium 226 (Pic/1)	Aquifer <u>2/</u>	Remarks
273528	813448	Hardee	17	12	03/12/75	0.20	SA	USGS monitor well
273532	814024	do.	26	21	02/27/75	.05	SA	Do.
273540	815216	do.	17	12	02/25/75	.20	SA	Do.
273541	820203	do.	18	13	02/25/75	1.9	SA	Do.
273659	815639	do.	23	18	02/26/75	.20	SA	Do.
273846	820320	Manatee	18	8	02/25/75	.20	SA	Do.
273847	813946	Polk	51	46	03/12/75	.20	UF	Do.
274925	815913	do.	24	21	12/04/74	.26	SA	Sand mine tailings
274942	815315	do.	22	17	02/26/75	.64	SA	USGS monitor well
275006	821442	Hillsborough	31	26	03/17/75	.20	SA	Do.
275020	813830	Polk	21	16	03/19/75	.20	SA	Do.
275110	820255	Hillsborough	17	12	03/11/75	4.5	SA	Do.
275121	815034	Polk	Slime Pit (S-1)		01/08/75	25	-	Pit filled with water and clay by-products
275129	820104	do.	80	60	12/10/74	1.5	UF	Domestic well

2/ See page 10 for explanation

Table 1.--Summary of radium-226 data from selected sites in Polk, Hardee, DeSoto, Manatee, and Hillsborough Counties, December 1974-March 1976. (Filtered, unacidified water samples.)--Continued

Latitude	Longitude	County	Well Depth		Date of Collection	Radium 226 (PiC/l)	Aquifer ^{2/}	Remarks
			Total (feet)	Casing (feet)				
275143	815044	Polk	700	272	12/04/74	1.6	LF	Water level observation well
275145	815044	do.	145	63	12/12/74	.37	UF	Do
275211	815101	do.	(a)	(a)	12/13/74	.58	UF	Near slime pit (S-1)
275216	815101	do.	(a)	(a)	do	1.5	UF	Do
275220	814830	do.	772	196	12/05/74	.79	LF	Agricultural - citrus processing near slime pit (S-1)
275221	814946	do.	(a)	(a)	01/08/75	14	UF	Near slime pit (S-1)
275308	815007	do.	(a)	(a)	12/12/74	.96	UF	Water well in Bartow area
275337	815233	do.	(a)	(a)	01/08/75	6.0	UF	Near slime pit (S-1)
275406	813745	do.	200	99	02/13/76	7.3	UF	Domestic well
275408	815957	do.	2,788	2,775	12/04/74	19	(a)	Monitor well at a chemical waste injection site

^{2/} (a) See page 10 for explanation.

Table 1.--Summary of radium-226 data from selected sites in Polk, Hardee, DeSoto, Manatee, and Hillsborough Counties, December 1974-March 1976. (Filtered, unacidified water samples.)--Continued

Latitude	Longitude	County	Well Depth		Date of Collection	Radium 226 (PiC/l)	Aquifer <u>2/</u>	Remarks
			Total (feet)	Casing (feet)				
273937	815159	Polk	23	20	12/03/74	4.4	SA	Completed in phosphate sands.
273937	815159	do.	do.	do.	03/03/76	5.7	SA	Do.
273950	814922	do.	22	17	02/26/75	.20	SA	USGS monitor well
274004	815330	do.	23	18	do	.54	SA	Do.
274033	820536	Hillsborough	11	11	12/10/74	1.5	SA	Domestic well
274043	813733	Polk	32	27	03/12/75	1.4	SA	USGS monitor well
274132	814143	do.	27	22	02/27/75	22	SA	Do.
274132	814143	do.	do.	do.	03/13/76	90		Do.
274154	815729	do.	27	22	02/25/75	.20	SA	Do.
274155	815732	do.	302	280	12/13/74	.14	LF	Observation well
274159	815645	do.	60	(a)	12/05/74	3.4	SA	Adjacent property mined for phosphate
274216	820847	Hillsborough	22	17	02/26/75	.20	SA	USGS monitor well
274217	821442	do.	22	17	03/17/75	.29	SA	Do.
274336	820336	do.	17	12	03/11/75	.20	SA	Do.

2/ (a) See page 10 for explanation

Table 1.--Summary of radium-226 data from selected sites in Polk, Hardee, DeSoto, Manatee, and Hillsborough Counties, December 1974-March 1976. (Filtered, unacidified water samples.)--Continued

Latitude	Longitude	County	Well Depth		Date of Collection	Radium 226 (PIC/1)	Aquifer ^{2/}	Remarks
			Total (feet)	Casing (feet)				
274400	820708	Hillsborough	826	246 <u>1/</u>	12/10/74	0.06	LF	Observation well in future phosphate mining area
274400	820708	do.	160	114 <u>1/</u>	do.	.24	UF	Do.
274400	813552	Polk	20	15	03/19/75	.20	SA	USGS monitor well
274438	814456	do.	122	84	12/10/75	.26	UF	Old irrigation well
274451	815316	do.	27	22	03/11/75	.20	SA	USGS monitor well
274505	814903	do.	23	18	02/25/75	.32	SA	Do.
274536	815938	do.	16	11	02/25/75	.28	SA	Do.
274544	821442	Hillsborough	22	17	02/25/75	.32	SA	Do.
274612	815035	Polk	(a)	(a)	12/05/74	5.3	SA	Domestic well indicating high Ra-226 in May 1974
274622	814141	do.	27	22	03/19/75	.20	SA	USGS monitor well
274712	815347	do.	803	284	12/02/74	1.5	LF	Industrial well
274729	814435	do.	39	34	03/19/75	7.7	SA	USGS monitor well
274731	820323	do.	15	10	03/11/75	2.0	SA	Do.
274748	815855	do	200	87	12/12/74	4.5	UF	Observation well in future mining area

1/ Duplicate sample (See Table 3)

2/ (a) See page 10 for explanation

Table 1.--Summary of radium-226 data from selected sites in Polk, Hardee, DeSoto, Manatee, and Hillsborough Counties, December 1974-March 1976. (Filtered, unacidified water samples.)--Continued

Latitude	Longitude	County	Well Depth		Date of Collection	Radium 226 (Pic/1)	Aquifer ^{2/}	Remarks
			Total (feet)	Casing (feet)				
274804	815857	Polk	17	22	02/25/75	0.09	SA	USGS monitor well
274902	820057	do.	289	20 to 52	12/13/74	1.2	SA/UF	Recharge - Connector well
274912	814906	do.	31	21	02/26/75	.46	SA	USGS monitor well
274914	814607	do.	31	21	02/25/75	1.8	SA	Do.
274925	814902	do.	39	37	12/04/74	.23	SA	Observation well - screen set in mine tailings
275408	815957	do.	1,348	1,270	12/04/74	1.2	LF	Monitor well at a chemical waste injection site
275514	820732	Hillsborough	23	18	03/11/75	.20	SA	USGS monitor well
275542	814642	Polk	173	84	12/11/74	.72	LF	Domestic well
275644	815519	do.	37	32	02/13/76	.64	SA	USGS monitor well
275711	820329	Hillsborough	60	39	03/05/76	1.6	UF	Old irrigation well
275717	815805	Polk	95	53	12/04/74	.61	SA	Domestic well
275736	814049	do.	22	17	03/18/75	2.2	SA	USGS monitor well
275754	815658	do.	120	77	12/04/75	.16	UF	Domestic well

^{2/} (a) See page 10 for explanation

Table 1.--Summary of radium-226 data from selected sites in Polk, Hardee, DeSoto, Manatee, and Hillsborough Counties, December 1974-March 1976. (Filtered, unacidified water samples.)--Continued

Latitude	Longitude	County	Well Total (feet)	Depth Casing (feet)	Date of Collection	Radium 226 (PiC/l)	Aquifer ^{2/}	Remarks
275918	820719	Hillsborough	22	17	02/25/75	0.94	SA	USGS monitor well
275948	815821	Polk	(a)	(a)	12/04/75	.13	LF	Domestic well
280334	815448	do.	58	31	03/04/76	1.2	UF	USGS monitor well

^{2/} Aquifer: SA, Shallow-sand aquifer; UF, Upper part of the Floridan aquifer; LF Lower part of the Floridan aquifer.

(a) Unknown.

10

exceeded the U.S. Public Health standard. Water from a slime pit and from a monitor well 2,788 feet (850 m) deep located at a chemical waste injection site had radium-226 activities of 25 and 19 piC/l respectively.

The high radium-226 activities which were detected during this reconnaissance were in waters from areas of phosphate mining and phosphate deposits. Because the sampling was limited to such phosphate areas, it is not known if high radium-226 activities are also present elsewhere in the State.

Additionally it should be noted, that the 3 piC/l limit is being reviewed (1976) by EPA and a radium-226 level is not given in the latest revision of the Interim Safe Drinking Water Act (EPA, 1975).

The analyses of the 36 acidified samples, 21 ground-water and 15 surface-water, are listed in table 2. The minimum activity detected was 0.09 piC/l in a 151-ft (46 m) well in Hamilton County. The maximum activity was 20 piC/l in water from a 160-ft (49 m) well that taps the upper part of the Floridan aquifer in Hillsborough County. In five (24 percent) ground-water samples and 1 (7 percent) surface-water sample, the radium-226 activity equaled or exceeded 3 piC/l.

The 13 surface-water samples collected in the Peace River drainage basin had a mean radium-226 activity of 0.94 piC/l, and a standard deviation of 0.91 piC/l. The minimum activity detected was 0.10 piC/l in the Manatee River at State Road 64 and the maximum was 3.6 piC/l in Little Charlie Creek at State Road 664A in Hardee County. Little Charlie Creek was the only stream sampled during the reconnaissance that had an activity exceeding 3 piC/l.

Five sites were sampled for duplicate analysis with one set of samples receiving no treatment and one set of samples receiving preanalysis acidification (table 3). Little difference in the radium-226 activity was observed between the unacidified and acidified samples in four of the duplicates. However, in one sample, (well in upper part Floridan aquifer Hillsborough County) the activity was much higher in the acidified sample. Particulate material in this sample is the probable source of the additional radium-226. Radium-226 would be dissolved from or desorbed from particulate material as a result of the acidification.

Table 2.--Summary of radium-226 data from selected sites in Suwannee, Columbia, Hamilton, Polk, DeSoto, Hillsborough, Hardee, and Manatee Counties Florida, December 1974 - March 1976.
(Filtered, acidified with 10 millilitres of 6 normal nitric acid per gallon of water sample.)

T	Location		County	Well Depth		Date of Collection	Radium-226 pCi/l
	R	S		Total (feet)	Casing (feet)		
2S	13E	24	Suwannee	290	180	12/10/74	0.47
2S	15E	15	do.	143	126	do.	.63
3S	17E	21	Columbia	110	108	12/13/74	1.0
1S	17E	33	do.	180	141	do.	1.4
2S	16E	30	do.	80	74	do.	1.9
3S	16E	1	do.	120	84	do.	.65
1S	15E	2	Hamilton	Surface water in area of		12/16/74	2.5
1S	13E	2	do.	Occidental Petroleum Corp. ^{1/}		do.	5.3
1S	14E	23	do.	150	103	12/17/74	3.0
1N	14E	8	do.	151	99	do.	.09
2N	13E	36	do.	151	128	do.	1.2
2N	13E	23	do.	130	80	do.	.55
1N	13E	2	do.	171	135	do.	13
2N	13E	14	do.	130	115	do.	.21
1N	14E	32	do.	180	130	do.	1.1
2N	18E	23	Columbia	260	181	do.	.83
27S	26E	28	Polk	500	100	01/03/75	1.8
26S	27E	7	do.	500	-	do.	1.0
28S	25E	11	do.	362	80	do.	1.6
27S	27E	4	do.	430	100	01/04/75	.99

^{1/} Slime pits

Table 2.--Summary of radium-226 data from selected sites in Suwannee, Columbia, Hamilton, Polk, Desoto, Hillsborough, Hardee, and Manatee Counties Florida, December 1974 - March 1976.
(Filtered, acidified with 10 millimetres of 6 normal nitric acid per gallon of water sample.)--Continued

T	Location		County	Well Depth		Date of Collection	Radium-226 pCi/l
	R	S		Total (feet)	Casing (feet)		
28S	26E	28	Polk	312	100	01/06/75	3.8
28S	26E	28	do.	Lake Water		01/06/75	1.1
37S	24E	26	DeSoto	Peace R. at Arcadia		12/06/74	1.5
30S	21E	17	Hillsborough	Lithia sps. ^{2/} nr. Lithia		-	.80
30S	26E	4	Polk	Lake Garfield nr Alturus		12/11/74	.36
30S	21E	16	Hillsborough	Alafia R. at ^{2/} Lithia		12/05/74	.53
32S	25E	2	Polk	Bowlegs Cr at SR 657		-	1.2
32S	22E	4	Hillsborough	160	114 ^{2/}	12/10/74	20
31S	25E	26	Polk	Peace River ^{2/} at Meade		12/06/74	.58
35S	21E	34	Manatee	Manatee R. at SR-64		-	.10
33S	24E	13	Hardee	Payne Cr at College Hill Rd		12/09/74	.32
32S	22E	4	Hillsborough	826	246 ^{2/}	12/10/74	.14
33S	25E	24	Hardee	Little Charlie Cr at SR-664A		-	3.6
34S	25E	22	do.	Peace R. at Zolpho Sp.		12/06/74	.51
29S	26E	34	Polk	Peace Cr Drainage Canal nr Alturus		12/11/74	.34
30S	25E	22	do.	Six Mile Creek		12/10/74	1.3

^{2/} Duplicate Sample (See Table 3).

Table 3.--Results of radium-226 analyses of split samples using two different pre-analysis procedures.

Description of the sampling site	Untreated sample	Acidified sample
	(Concentrations in Picocuries per litre)	
Lithia Springs nr Lithia	0.68	0.80
Alafia River at Lithia	0.60	.53
Peace River near Fort Meade	0.12	.58
Well in the upper part of the Floridan aquifer in Hillsborough Co., 160 ft deep	.24	20
Well in the lower part of the Floridan aquifer in Hillsborough Co., 826 ft deep	.06	.14

SUMMARY AND CONCLUSIONS

Of the 115 samples analyzed, 22 had a radium-226 activity equal to or exceeding 3 pCi/l. Fourteen of the samples were from Polk County, three were from Hamilton County, two were from Hillsborough County and one each from DeSoto, Manatee, and Hardee Counties. Radium activities exceeding 3 pCi/l were detected in water wells ranging from 17 to 2,788 ft (7 to 850 m) in depth. An activity of 90 pCi/l detected in a shallow well in Polk County was the highest radium-226 level measured during the reconnaissance. The lowest radium-226 level was 0.05 pCi/l measured in a U.S. Geological Survey monitor well in the shallow-sand aquifer in northern Hardee County. Little Charlie Creek at State Road 664A had a radium-226 activity of 3.6 pCi/l and was the only surface-water site that had a radium-226 activity exceeding 3 pCi/l, except for the slime pits in Polk and Hamilton Counties.

The results of this study indicate that in some waters associated with phosphate mining or phosphate ores high radium activities are present. However the sampling was limited to the phosphate area and, based on these data, it is not known if high activities are present in waters in other parts of Florida.

A statewide program for monitoring radium-226 levels in ground water should be established. A monitoring program is particularly necessary in those areas where there is a possibility of radium-226 contamination in domestic water supplies.

REFERENCES CITED

- Environmental Protection Agency, 1974, Report on Radiological Pollution from Phosphate Rock Mining and Milling: National Field Investigations Center - Denver, Denver, Colorado, 29 p.
- _____, 1975, National interim primary drinking water regulations (Public Law 93-532): Federal Register v. 40, no. 248, December 24, p. 59566-59588.
- U.S. Public Health Service, 1962, Drinking Water Standards, 1962: Pub. 956, 61 p.
- A statewide program for monitoring radium-226 levels in ground water should be established. A monitoring program is particularly necessary in those areas where there is a possibility of radium-226 contamination in domestic water supplies.
- The results of this study indicate that in some waters associated with phosphate mining or phosphate ore high radium-226 levels are present. However, the sampling was limited to the phosphate area and based on these data, it is not known if high activities are present in waters in other parts of Florida.
- Peace River area near Fort Meade.
- LA had a radium-226 activity of 3.6 pCi/l and was the only water source that had a radium-226 activity exceeding 3 pCi/l, except for a slight spike in Folk and Hamilton Counties.

USGS LIBRARY - RESTON



3 1818 00100495 9

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
325 John Knox Rd., F-240
Tallahassee, Florida 32303

FIRST CLASS MAIL

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR
INT. 413