NEW MEXICO ENERGY INSTITUTE

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A STUDY OF SILICIC PLUTONIC ROCKS IN THE ZUNI AND FLORIDA MOUNTAINS TO EVALUATE THE POSSIBLE OCCURRENCE OF DISSEMINATED URANIUM AND THORIUM DEPOSITS

URANIUM AND THORIUM ABUNDANCES AND WHOLE ROCK CHEMISTRY OF THE FLORIDA MOUNTAINS, NEW MEXICO: PRELIMINARY STUDY

NMEI REPORT NO. 77-1104C

DECEMBER 1978

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Uranium and Thorium Abundances and Whole Rock Chemistry of the Florida Mountains, New Mexico: Preliminary Study

Final Report

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by

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abstract

The uranium and thorium abundances in the Precambrian granitic and of the syenitic rocks (age unknown) of the Florida Mountains have been analyzed by delayed neutron activation analysis. The average uranium content of 90 surface and drill core samples is 3.12 ppm and thorium content for 66 samples is 12.33; Th/U = 3.97, well within the normal range for granitic rocks (3.7 - 4.2). Although the Th/U ratio is normal for granitic and syenitic rocks, a negative correlation between uranium (and Th/U) with Al_2O_3, K_2O, and (K_2O + Na_2O) is observed. This may be due to (a) derivation of the syenitic rocks from parent, low uranium gabbroic rocks or (b) uranium loss during weathering. For the latter, significant amounts of uranium may have been removed and possibly not transported far from the source area. The syenitic rocks do not possess high uranium contents typical of other areas.

Introduction

The Florida Mountains, south-central New Mexico are of interest because of the presence of syenitic rocks (Corbitt, 1971) and the assumed association of uranium enrichment with uranium. This assumption prompted part of this study, viz. to determine if the rocks of the Florida Mountains were indeed uranium rich and, if so, whether they represented a possible, low grade uranium resource. If uranium poor, then uranium loss may be postulated which would indicate that uranium exploration in the surrounding sediments may be justified.

The Florida Mountains are very complex geologically; syenites originally mapped as Mesozoic by Corbitt (1971) have been indicated as much older (i.e., from early Phanerozoic (?) to Precambrian; Brookins, 1974). Whole rock chemical studies and petrographic studies have also been carried out to help assess the relationship between the granitic rocks and those with syenitic affinities. Some of this work is still in progress, and additional age work is contemplated and essential to attempt any material balance between the granites and syenites.

Uranium and Thorium Investigation

The uranium abundance in the Florida Mountains is of interest for several reasons. First, the rocks in which one might logically expect uranium enrichment, viz. syenites and quartz syenites, are depleted in uranium and thorium and Th/U is also low. Secondly, syenites typically show a positive correlation between potassium (or potassium plus sodium) and uranium. In Figures 2 to 5 are plotted U vs. K_2O, U vs. Al_2O_3, Th/U vs. Al_2O_3, and U vs. (Na_2O + K_2O). In all cases uranium shows a negative correlation with increasing alkali and alumina content. Despite scatter, this holds true for surface samples as well as drill core samples. These data may be interpreted in several ways, the two most obvious explanations are: (1) The syenites were derived from an alkali gabbro parent with low Th and U; this model is possible as hornblende gabbro, presumably gradational into syenite, is noted in the northern Floridas by Corbitt (1971). (2) Uranium has systematically been lost due to weathering or other processes. If (2) is correct, then, assuming normal U in the range of 4-5 ppm for granitic to syenitic rocks, some one million tons of uranium may (hypothetically) have been released from just 100 km^3 of rock. This in turn indicates that either high uranium in stream sediments near the Floridas might result or that small (?) uranium deposits may be found in some of the sediments/sedimentary rocks nearby. Critical to evaluating (1) versus (2) is the exact age relationship between the granites and syenites; Brookins (1974) has suggested that the syenites are not coeval with the granites, but how much younger has not been resolved. This problem needs much more detailed work.

The Th/U ratio for the Florida samples is shown as Figure 6; despite the positive correlation, deviation from Th/U = 4 is apparent. The U and Ti correlation is tested in Figure 7; a negative correlation between U and Ti is indicated with Ti enriched in the U-depleted syenitic rocks. Surface samples and drill core samples show the same trend. Collectively these data indicate, as mentioned earlier, that a systematic variation between granitic and syenitic rocks exists. The problem of temporal relationship between the two rocks remains unsolved.

Whole Rock Chemistry

The whole rock chemistry for the Florida samples is presented in Table 2. Although rocks mapped as syenites (FM-3, FM-4, FM-7 (upper six samples), FM-8) are justified based on petrography (See appendix), their SiO_2 contents are slightly higher than normal syenites, a point made by Brookins (1974) and Brookins and Corbitt (1974). High total alkalis and alumina support classification as syenites. Those rocks identified as granites possess SiO_2 contents from 71-77 percent and are characterized by lower alumina, total alkalies, titania. Iron is not systematically distributed between the various rocks although it is fairly constant for any one drill hole thus suggesting relatively little iron loss.

The whole rock chemical data will be more carefully interpreted when trace element data are available and additional Rb-Sr studies have been completed.

Acknowledgments

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Brookins, D. G., and Corbitt, L. L., 1974, Preliminary Rb-Sr Study of Igneous Rocks of the Florida Mountains, New Mexico: EOS Trans. Am. Geophys. Un., v. 55, p. 470-471.

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TABLE 1

Th and U Data: Florida Mountains

Sample	Th (ppm)	U (ppm)	Th/U
FM5-1	13.65	3.08	4.43
FM5-3	35.8	7.80	4.59
FM5-5	15.0	3.65	4.11
FM2-1	16.4	4.03	4.07
FM7-3	2.40	1.58	1.52
FM8-1	12.9	2.88	4.48
FM2-2	15.0	2.80	5.36
FM7-4	3.70	2.39	1.55
FM7-2	3.63	1.77	2.05
FM2-4	18.2	4.81	3.78
FM1-6	17.4	3.03	5.74
FM7-1	3.15	1.42	2.22
FM7-6	30.8	7.08	4.35
FM-11	18.6	3.89	4.78
FM7-8	4.26	1.83	2.33
FM8-2	17.1	3.69	4.63
FM2-8	18.4	4.22	4.36
FM7-5	3.69	1.65	2.24
FM1-3	24.6	5.44	4.52
FM7-5	13.0	2.76	4.71
FM4-1	7.26	1.87	3.88
FM5-6	19.8	4.18	4.74
FM1-2	23.1	4.56	5.07
FM1-7	12.9	2.33	5.54
FM2-5	11.5	2.57	4.47
FM1-5	16.3	4.17	3.91
FM4-4	2.67	1.50	1.78
FM4-2	5.08	1.25	4.06
FM4-3	3.29	1.47	2.24
FM5-2	18.9	2.77	6.82
FM2-3	14.5	3.15	4.54
FM1-4	16.2	3.35	4.84

TABLE 1 (continued)

Sample	Th (ppm)	U (ppm)
F1183	--	2.98
F1184	--	3.05
F1185	--	8.04
F1187	--	3.63
F1188	--	1.38
F1189	--	5.53
F1190	--	1.53
F1191	--	1.48
F1192	--	7.73
F1193	--	3.44
F1194	--	4.80
F1195	--	3.56
F1196	--	5.61
F1197	--	2.62
F1198	--	6.43
F1199	--	1.55
F1200	--	1.16
F1201	--	2.60
SP9W10	12.8	4.10
CDSWSE10	19.0	4.40
GPSWSW97	3.14	1.55
SPE4	7.23	1.76
SPSW3	11.4	2.55
GPNE31	11.1	3.65
SPSENE26	16.4	3.80
SPSESE15	24.6	5.95
CDSWNW18	2.48	1.64
CDNW34	2.01	0.86
GPNWNW18	28.3	7.50
SPSWSW26	22.3	4.73
GPNENE24	12.66	3.45
SPSWSW22	4.74	2.15

TABLE 1 (continued)

Sample	Th (ppm)	U (ppm)
GPCNW31	2.33	1.66
GPCNW6	2.05	1.48
SPNWNE23	2.54	2.02
SPC4	14.49	4.02
SPWC19	7.69	2.86
SPNWNW25	19.1	3.07
SPSW36	--	3.63
GPCNE31	10.6	2.36
GPNE13	6.22	1.68
CENENE10	--	2.69
CDSW3	--	1.77
GPSESE14	--	0.65
SP9 + SW10	4.22	1.37
GPSESE14	9.33	3.58
SPSWSW36	1.95	1.55
CDNE10	15.98	3.20
SP9	4.67	1.25
CDCNE3	3.34	1.40
GPNESW12	23.8	3.33
GPNWNW24	18.1	3.95
GPNESW14	8.75	1.86
SPSSW3	6.08	1.22

NOTES:

(1) FM samples from drill core (see Fig. 1)

(2) F1183-1202 surface samples; see Brookins (1974)

(3) CD = Capitol Dome Quadrangle (Corbitt, 1971)

(4) GP = Gym Peak Quadrangle (Corbitt, 1971)

(5) SP = South Peak Quadrangle (Corbitt, 1971)

TABLE 2

Whole Rock Analyses -- Florida Mountains

	FM1-1	FM1-2	FM1-3	FM1-4	FM1-5	FM1-6	FM1-7	FM1-8
SiO_2	71.42	71.92	70.90	72.46	71.42	72.14	71.10	70.79
TiO_2	.35	.29	.26	.28	.30	.30	.33	.30
Al_2O_3	13.03	12.54	12.36	12.49	12.56	13.10	12.63	13.07
Fe_2O_3	4.83	5.02	6.66	5.02	5.42	3.98	4.96	4.42
MgO	.19	.29	.63	.32	.61	.24	.47	.49
CaO	.34	.42	.37	.35	.49	.40	.38	.53
Na_2O	4.28	4.04	3.32	3.57	3.61	4.38	4.10	4.12
K_2O	4.94	4.70	4.62	4.77	4.88	4.88	5.05	5.15
total	99.38	99.22	99.12	99.26	99.29	99.42	99.02	98.87

	FM2-1	FM2-2	FM2-3	FM2-4	FM2-5	FM2-7	FM2-8	FM3-1
SiO_2	77.42	76.85	74.28	76.76	73.48	74.98	74.56	64.58
TiO_2	.32	.32	.40	.33	.48	.40	.52	.28
Al_2O_3	11.68	11.19	11.63	11.05	12.55	12.26	12.49	15.80
Fe_2O_3	2.32	4.14	5.30	4.45	4.54	4.69	3.83	5.85
MgO	.18	.14	.21	.13	.23	.15	.10	.56
CaO	.02	nd	nd	nd	nd	nd	nd	.48
Na_2O	2.38	2.31	2.47	2.26	3.03	2.95	2.85	4.00
K_2O	5.06	4.67	5.10	4.67	5.21	5.16	5.41	6.44
total	99.38	99.62	99.39	99.65	99.52	100.59	99.76	97.99

	FM3-2	FM3-3	FM4-1	FM4-2	FM4-3	FM4-4	FM4-5	FM5-1
SiO_2	63.36	62.86	61.85	60.47	59.78	61.15	60.88	72.41
TiO_2	.24	.35	1.08	1.24	1.39	1.14	1.30	.31
Al_2O_3	17.36	16.29	16.52	16.35	16.67	17.12	16.99	13.20
Fe_2O_3	6.10	7.61	5.18	6.32	6.57	5.54	6.06	3.98
MgO	.56	.41	1.15	1.84	1.81	1.66	1.79	.20
CaO	.44	.45	2.11	2.52	2.40	1.90	1.69	.30
Na_2O	4.00	4.32	6.80	6.74	7.20	6.82	6.89	2.85
K_2O	5.77	5.66	5.79	5.43	5.51	5.77	5.84	5.04
total	97.83	97.95	100.48	100.91	101.33	101.10	101.44	98.29

	FM5-2	FM5-3	FM5-4	FM5-5	FM5-6	FM7-1	FM7-2	FM7-3
SiO_2	73.50	70.10	73.54	73.90	75.20	65.56	64.56	65.14
TiO_2	.31	.65	.33	.27	.28	.69	.74	.80
Al_2O_3	12.27	12.38	12.61	12.48	11.80	18.96	18.12	18.58
Fe_2O_3	4.17	7.36	4.14	3.71	4.02	1.03	3.08	1.47
MgO	.19	.32	.16	.20	.13	.43	.32	.36
CaO	.35	.16	.20	.24	.12	.48	.41	.53
Na_2O	3.80	3.74	4.33	4.11	3.86	6.65	6.66	6.69
K_2O	4.79	4.56	4.29	4.53	4.36	6.58	6.29	6.74
total	99.38	99.27	99.60	99.44	99.77	100.38	100.18	100.31

	FM7-4	FM7-5	FM7-6	FM7-7	FM7-8	FM8-1	FM8-2
SiO_2	65.09	64.66	70.45	70.41	63.77	68.23	67.94
TiO_2	.63	.58	.26	.30	.68	.32	.29
Al_2O_3	18.06	18.24	15.20	16.02	17.42	14.31	14.56
Fe_2O_3	2.44	2.44	2.59	1.32	4.48	4.40	4.00
MgO	.49	.40	.30	.26	.43	.24	.19
CaO	.49	.47	.17	.21	.41	.58	.68
Na_2O	6.58	6.61	5.14	5.75	6.45	5.74	6.44
K_2O	6.30	6.52	5.44	5.53	6.19	5.45	5.42
total	100.08	99.92	99.55	99.80	99.83	99.27	99.52

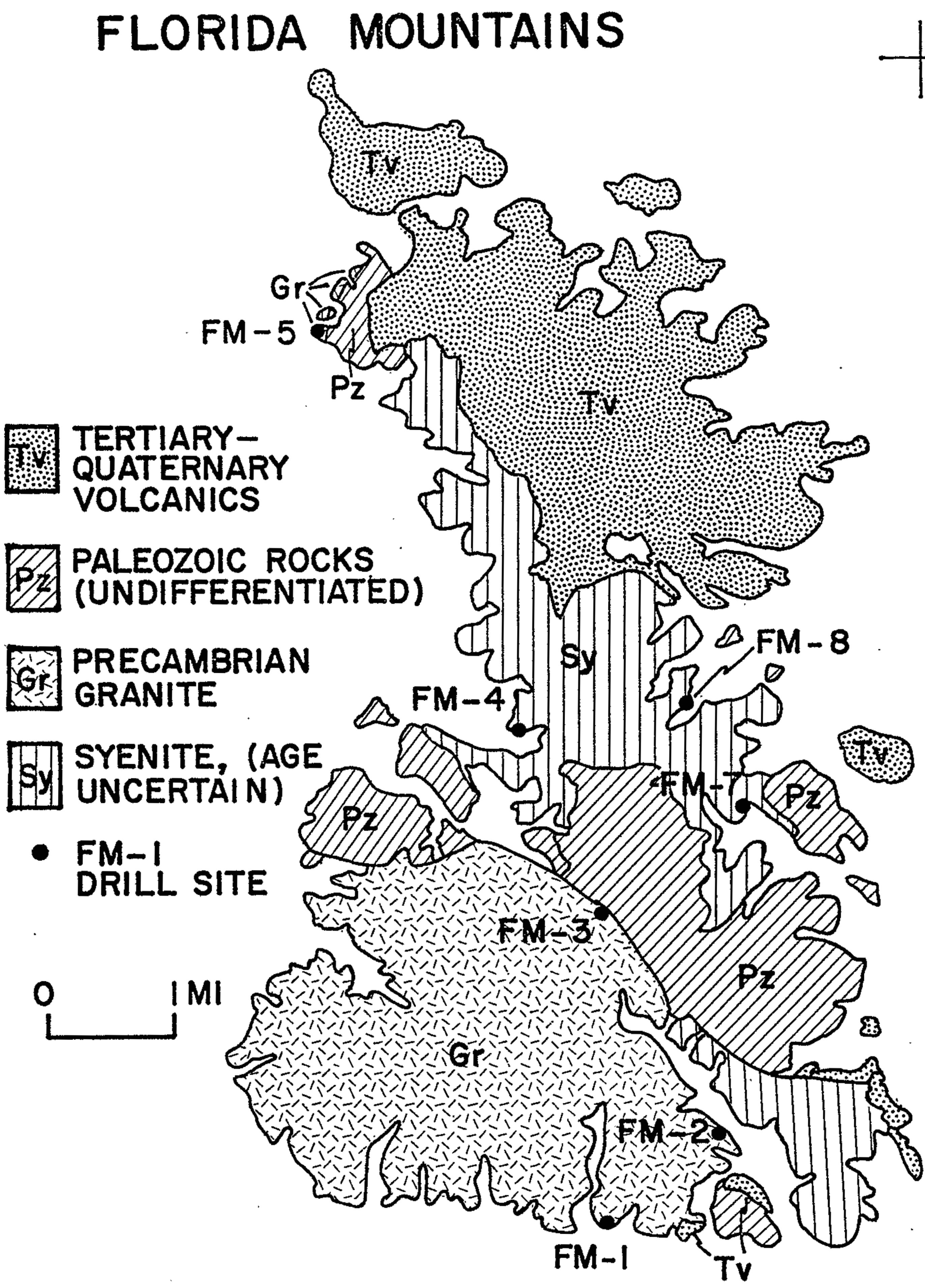
FLORIDA MOUNTAINS
Tv
Gr
FM-5
Pz
Tv
TERTIARY-QUATERNARY VOLCANICS
PALEOZOIC ROCKS (UNDIFFERENTIATED)
PRECAMBRIAN GRANITE
SYENITE, (AGE UNCERTAIN)
FM-1 DRILL SITE
Sy
FM-8
FM-4
Tv
FM-7
Pz
Pz
FM-3
O
I MI
Pz
Gr
FM-2
FM-1
Tv

FIGURE 1

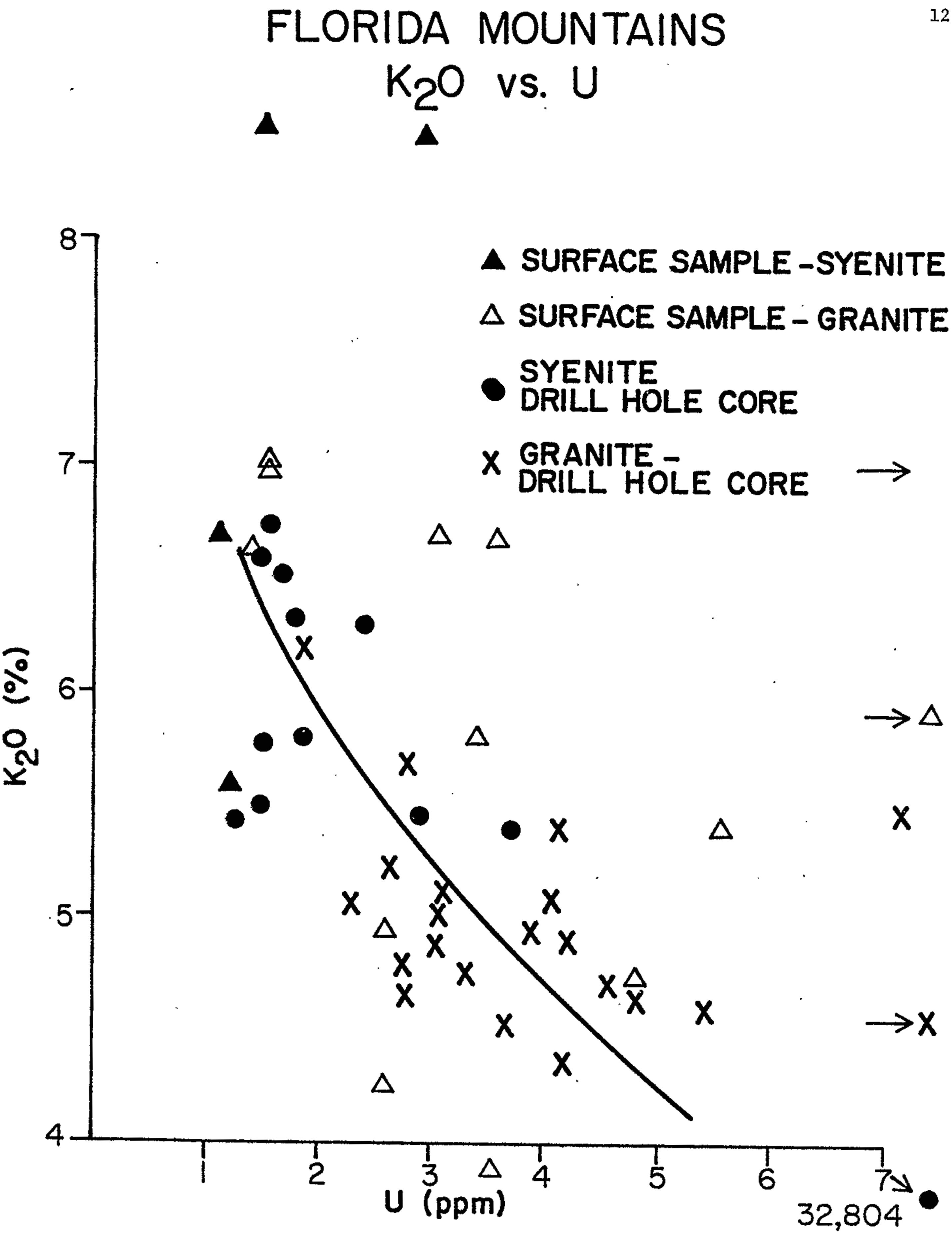
FLORIDA MOUNTAINS
K2O vs. U
SURFACE SAMPLE-SYENITE
SURFACE SAMPLE-GRANITE
SYENITE DRILL HOLE CORE
GRANITE-DRILL HOLE CORE
K2O (%)
8
7
6
5
4
1
2
3
4
5
6
7
U (ppm)
32,804

FIGURE 2

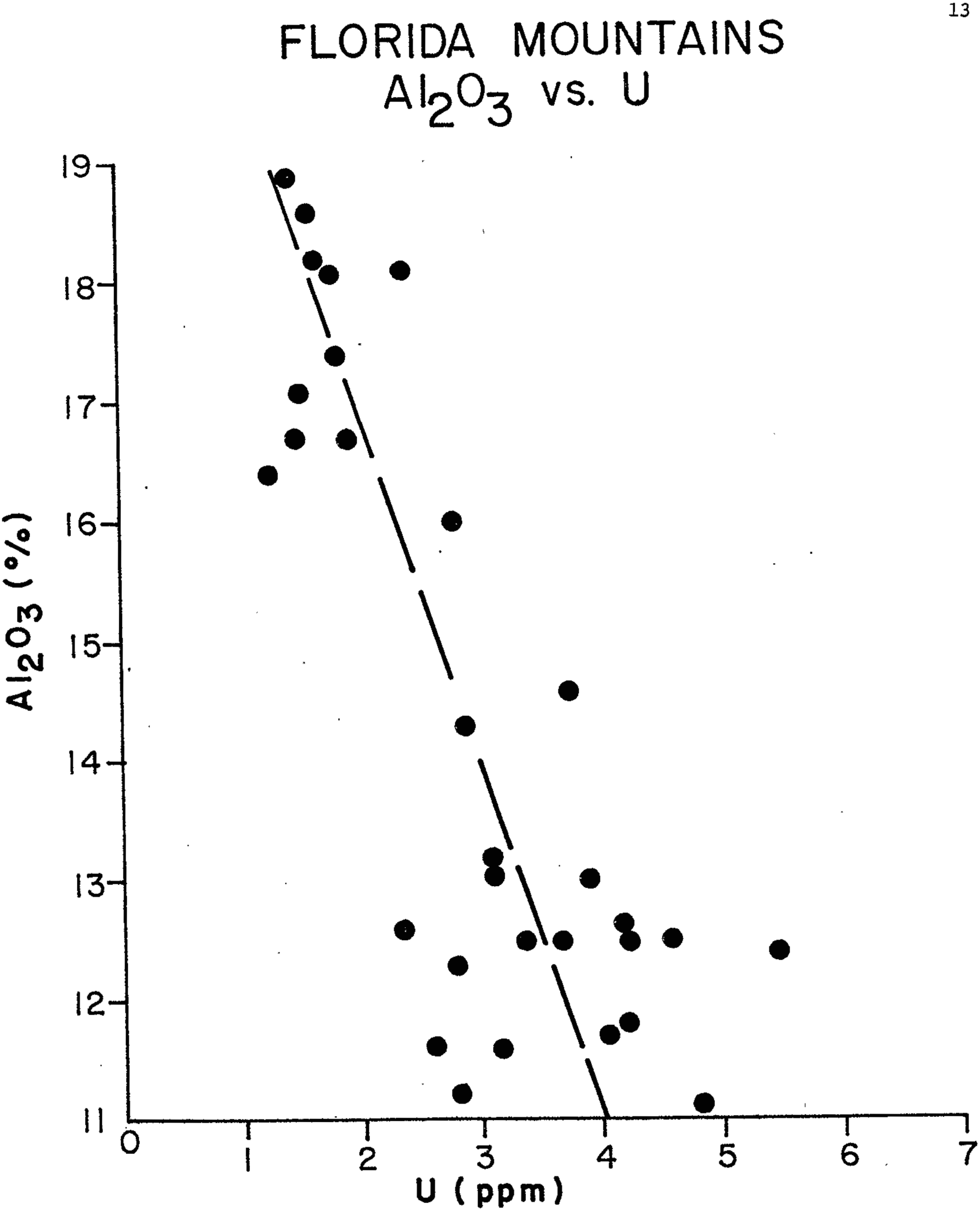
FLORIDA MOUNTAINS
Al_2O_3 vs. U
Al_2O_3 (%)
19
18
17
16
15
14
13
12
11
0
1
2
3
4
5
6
7
U (ppm)

FIGURE 3

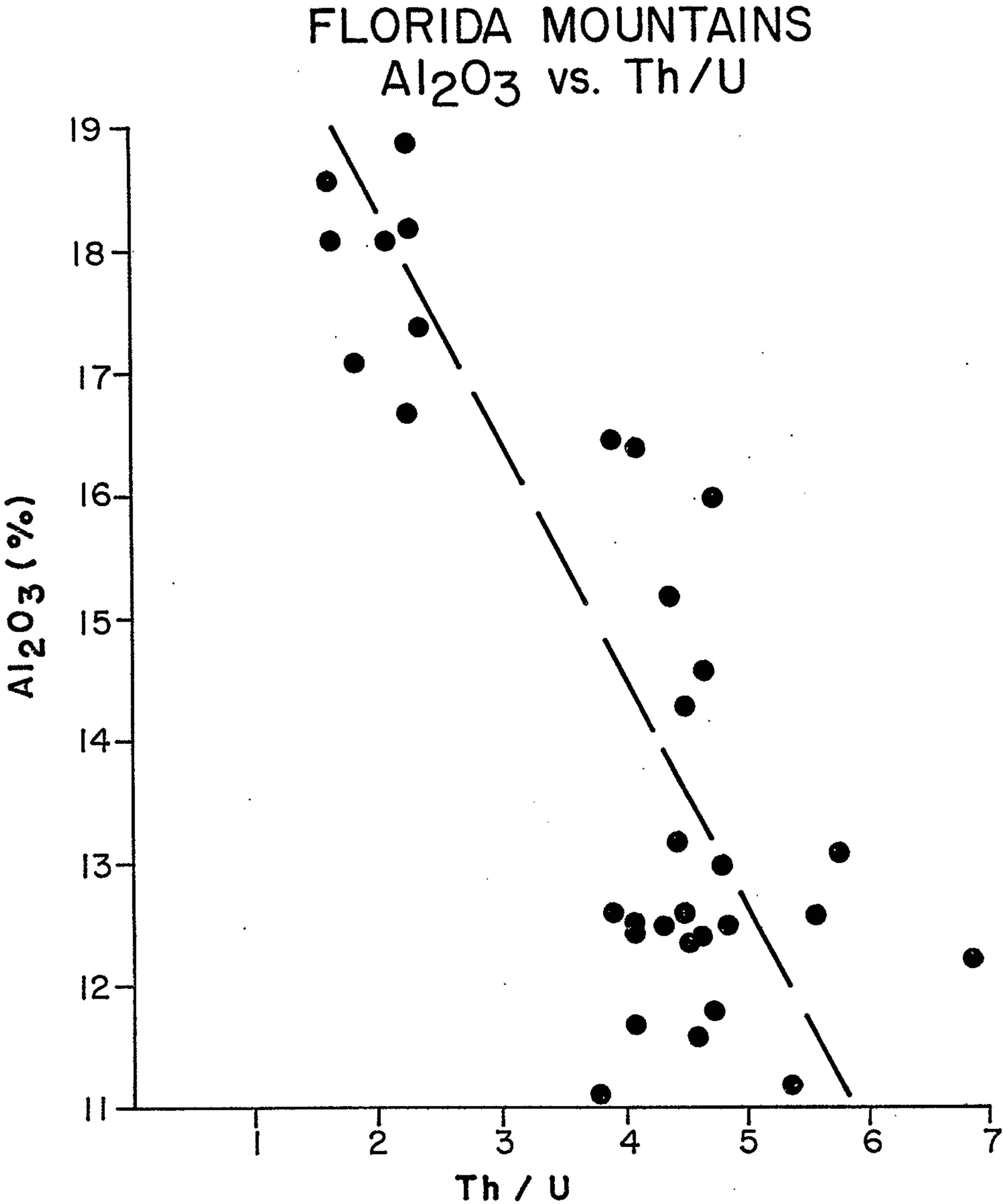
FLORIDA MOUNTAINS
Al2O3 vs. Th/U
Al2O3 (%)
19
18
17
16
15
14
13
12
11
1
2
3
4
5
6
7
Th / U

FIGURE 4

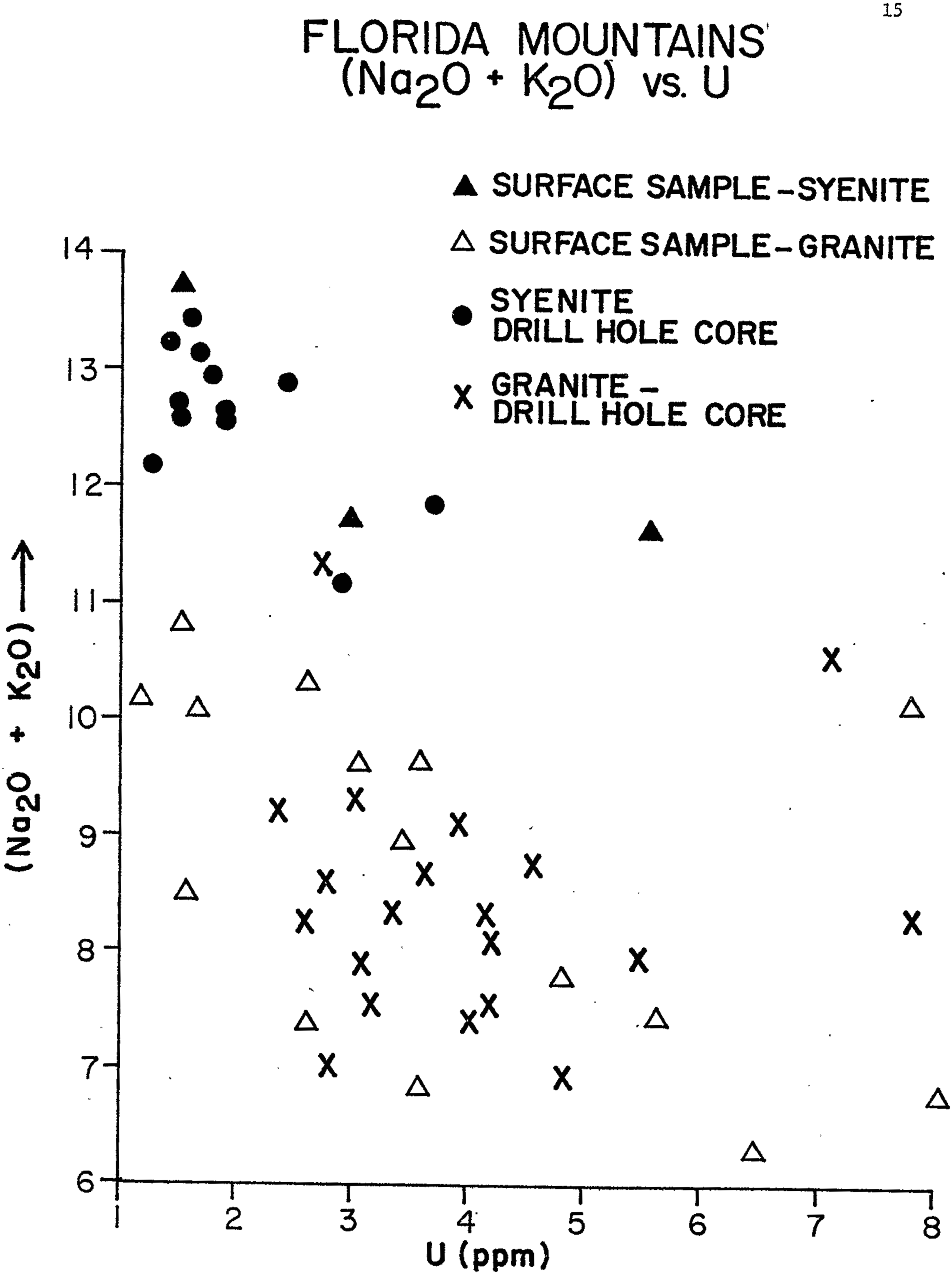
FLORIDA MOUNTAINS
(Na2O + K2O) vs. U
SURFACE SAMPLE - SYENITE
SURFACE SAMPLE - GRANITE
SYENITE
DRILL HOLE CORE
GRANITE -
DRILL HOLE CORE
(Na2O + K2O)
14
13
12
11
10
9
8
7
6
1
2
3
4
5
6
7
8
U (ppm)

FIGURE 5

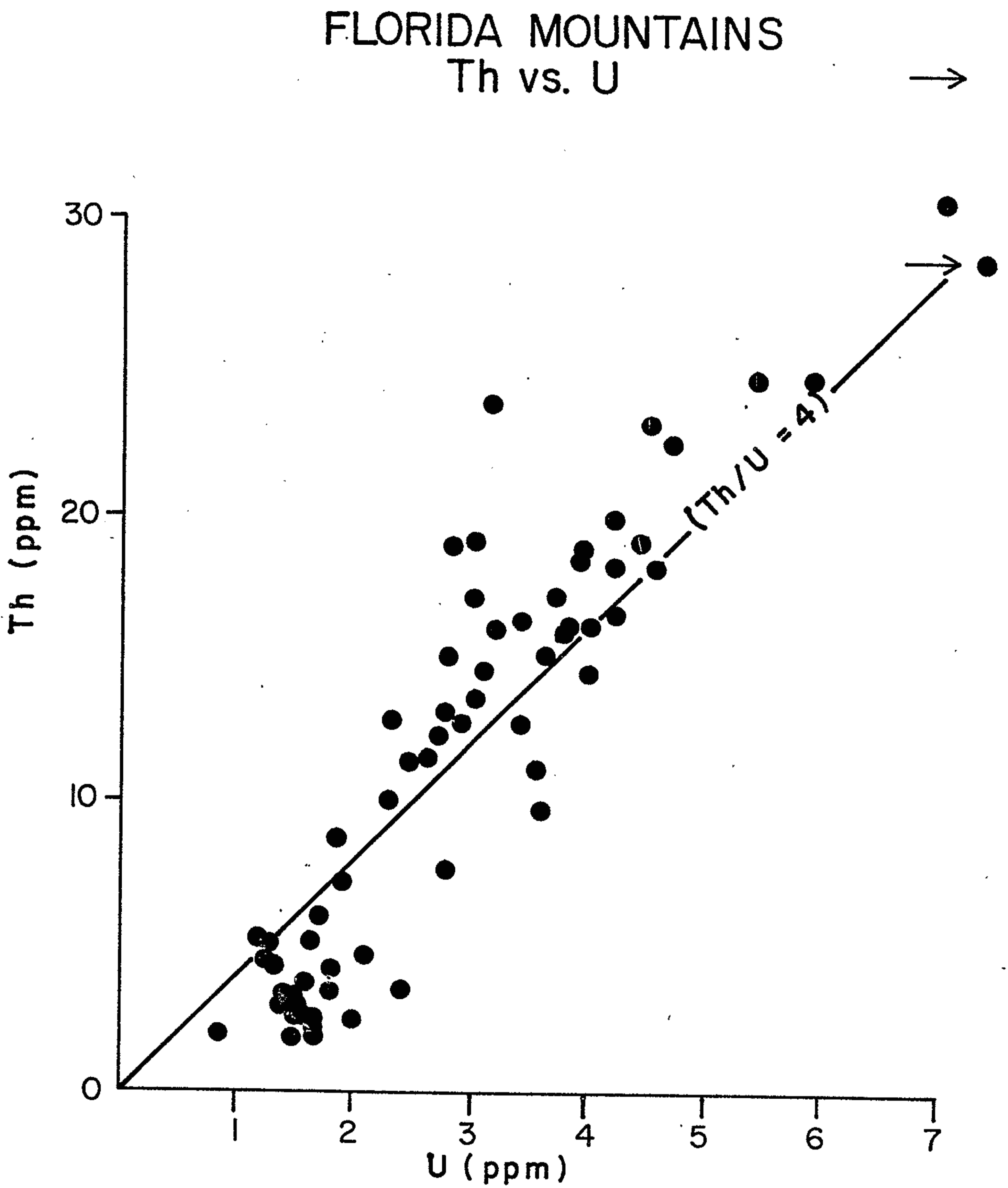

FIGURE 6

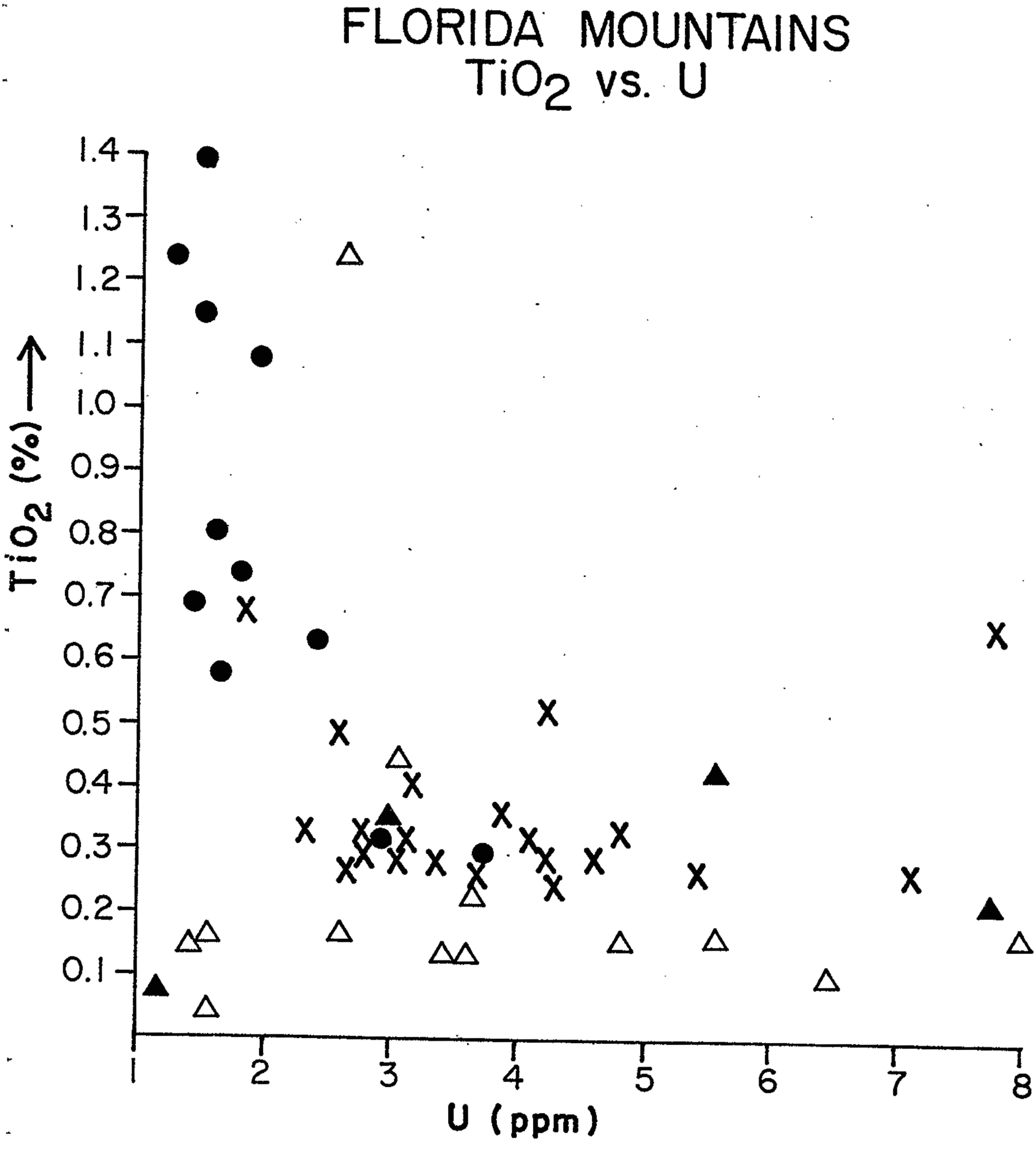
FLORIDA MOUNTAINS
TiO2 vs. U
TiO2 (%) ⟶
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
1
2
3
4
5
6
7
8
U (ppm)

FIGURE 7

FLORIDA MOUNTAINS

Sample Descriptions and Specimen Status

Spec. No.	Location	Depth	Map Unit
FM1-1	NE/SE/NE/23/26S/8W	0- 5	gr
-2		5-10	gr
-3		10-15	gr
-4		15-20	gr
-5		20-25	gr
-6		25-30	gr
-7		30-40	gr
-8		40-50	gr
FM2-1	SE/NE/SE/13/26S/8W	0- 5	gr
-2		5-10	gr
-3		10-15	gr
-4		15-20	gr
-5		20-25	gr
-6		25-30	gr
-7		30-35	gr
-8		35-40	gr
FM3-1	NE/SE/SE/2/26S/8W	0- 5	gr
-2		5-10	gr
-3		10-15	gr
F M4-1	SW/NE/NE/35/26S/8W	0- 5	sy
-2		5-10	sy
-3		10-15	sy
-4		15-20	sy
-5		20-21	sy
FM5-1	NW/SW/SE/10/25S/8W	0- 5	gr(N)
-2		5-10	gr(N)
-3		10-15	gr(N)
-4		15-20	gr(N)
-5		20-25	gr(N)
-6		25-30	gr(N)
FM7-1	SW/SW/SE/31/25S/7W	0-10	sy
-2		10-20	sy
-3		20-30	sy
-4		30-35	sy
-5		35-40	sy
-6		40-45	sy
-7		45-50	gr
-8		50-55	gr
FM8-1	NW/NE/NW/31/25S/7W	0- 5	sy
-2		5-10	sy

FLORIDA MOUNTAINS

Description and Location of Rocks

1. Orthoclase Granite
   Sections 10, 11, 14 T. 25 S., R. 8 W. Capital Dome area.

2. Hornblende Perthite Syenite to Quartz Syenite
   Sections 25, 35, 36 T. 25 S., R. 8 W.
   NW Portions Sections 6, 18 T. 26 S., R. 7 W.
   Mostly north of major fault.

3. Perthite Biotite Syenite
   Section 25 T. 25 S., R. 8 W.
   Sections 30, 31 T. 25 S., R. 7 W.
   North of major fault.

4. Perthite Quartz Syenite
   Section 36 T. 25 S., R. 8 W.
   Section 31 T. 25 S., R. 7 W.
   North of major fault.

5. Hornblende Perthite Granite
   Sections 25, 36 T. 25 S., R. 8 W.
   Section 31 T. 25 S., R. 7 W.
   Sections 9, 10, 14 T. 26 S., R. 8 W.
   Section 18 T. 26 S., R. 7 W.
   Identical to hornblende perthite syenite and perthite syenite except more quartz.

6. Orthoclase Plagioclase Microcline Perthite Granite
   Sections 2, 9, 10, 12, 13, 14, 15, 16, 23, 24 T. 26 S., R. 8 W.
   Sections 18, 19 T. 26 S., R. 7 W.
   South of major fault.

LOCATION			ROCK			
FM4-3-	Brecciated	Hornblende	Perthite	Quartz		Syenite
FM4-5-	Hornblende	Perthite	Quartz	Syenite		
SPNW-25-	"	"	"	"		
SPNW-25*-	"	"	"	"		
SPNENE-35-	"	"	"	"		
GPNWNW-6-	"	"	"	"		
GPCNW-6B-	"	"	"	"		
GPNWNW18B	"	"	"	"		
SPNENE-25-	Biotite	Perthite	Quartz	Syenite	(calcito)	
GPSWNE-30-	"	"	"	"		
GPCNE-31A-	"	"	"	"		
SPNWNE-23-	Perthite	Quartz	Syenite			
SPSESE-23-	"	"	"			
SPCNE31B-	"	"	"			
SPSWSE31-	"	"	"			
CDCNE31-	"	"	"			
FM7-4-	Perthite	Quartz	Syenite			
FM7-6-	Perthite	Plagioclase	Quartz	Syenite		
SPSW-36-	Brecciated	Perthite	Quartz	Syenite		
SPSWSE36-	Brecciated	Perthite	Orthoclase	Quartz		Syenite
FM8-2	Hornblende	Perthite	Granite			
SPNWNW25-	"	"	"			
SPSENE-26A-	"	"	"			
SP-SW-36(?)-	"	"	"			
GPNW-31A-	"	"	"			
SPSENE-14-	"	"	"			
GPSENE14	"	"	"			
SP9+SW-10A	"	"	"			
SP9+SW-10B	"	"	"			
S999W-10-	"	"	"			
SPSENE26B-	Perthite	Granite				
SPWNE-26-	"	"				
SPSESE-26-	"	"				
SPNENE-35-	"	"				
SPSW-36A-	"	"				
SPSESE-2-	"	"				
SPNE-2-	"	"				
SPNESE-4-	"	"				

(Cont.)

(cont.)

LOCATION		ROCK		
SPE-4-	Perthite	Granite		
SPCN-4	"	"		
SPSW-3A-	"	"		
SPSW-3B-	"	"		
SPSSW-3-	"	"		
GPNWNW-18C-	"	"		
GPSESE-14C-	"	"		
GPNWSE-14-	"	"		
GPNENE-23-	"	"		
SPSWNW-16	"	"		
GPESE 14	"	"		
FM 1-8	"	"		
SPNESE 26-	Brecciated	Perthite	Granite	
SP-SW?NW?-2-	"	"	"	
SPSW-3- -	"	"	"	
SPSW-3C-	"	"	"	
SPSW-3E-	"	"	"	
SPSWSW9-	"	"	"	
FM-3-	Perthite	Orthoclase	Granite	
SP-SW-3D-	"	"	"	
SPSW-3-	Orthoclase	Granite		
SP9+W-10B-	Orthoclase	Plagioclase	Granite	
SPSW16	Orthoclase	Perthite	Granite	
FM5-2	Orthoclase	Granite		
FM5-6	"	"		
CDNE-10	"	"	(Calcite)	
CDSWSE-10	Granophyric	Orthoclase	Granite	
GPNESW-12	Perthite	Plagioclase	Granite	
GPSWSW-13	"	"	"	
GPSESE-14B	Perthite	Granite		
SPNWNW-14?	Perthite	Orthoclase	Plagioclase	Granite
GPCSE14	"	"	"	"
GPSWNE14	"	"	"	"
GPSWNW14	"	"	"	"
GPNESW14	"	"	"	"
SPSESE-14-15 or R	"	"	"	"
SPSE16D	"	"	"	"
SPSE16B	"	"	"	"
SPSE-45?	"	"	"	"

LOCATION			ROCK		
SPSWSE15	Granophyric	Perthite	Orthoclase	Plagioclase	Granite
GPNESE13	Perthite	Orthoclase	Microcline	Plagioclase	Granite
GPSW31B	Granophyric	Perthite	Orthoclase	Granite	
FM2-8	Granophyric	Perthite	Orthoclase	Plagioclase	Granite
SP99SW10A	Perthite	Orthoclase	Quartz	Granite	
GPSESE14A	Perthite	Orthoclase	Granite		
CDSWSW14	Orthoclase	Perthite	Plagioclase	Granite	
SPSESE14	Orthoclase	Perthite	Granite		
SPSESE-15	Granophyric	Perthite	Orthoclase	Plagioclase	Granite
SPSE16E	Microcline	Perthite	Granite		
GPSWNW18	Hornblende	Orthoclase	Plagioclase	Granite	
GPNWNW24	Orthoclase	Plagioclase	Granite		
GPNENE24	Orthoclase	Perthite	Granite		
GPSWSE10A	Granophyric	Orthoclase	Granite		
SP9+W10A	Plagioclase	Orthoclase	Granite (Calcite)		
GPNWNW18A	Orthoclase	Plagioclase	Granite		
SPSE45?	Granophyric	Perthite	Orthoclase	Plagioclase	Granite
CDNWNE14	Perthite	Plagioclase	Granite		
CDSWSW11	Orthoclase	Granite			
CDSW11	"	"			
GPSWSW17?	Perthite	Granite			
GP-SWNE36	Orthoclase	Quartz	Syenite (Calcite)		
GP-SW31A	Biotite	Orthoclase	Syenite		
SPSENW16	Perthite	Orthoclase	Quartz	Syenite	
SPSWNE12	"	"	"	"	
SPE17	"	"	"	"	
SPSWSW22?	"	"	"	"	
SPCNW6A	Perthite	Orthoclase	Plagioclase	Quartz	Syenite
SPCNE34C?	Biotite	Perthite	Orthoclase	Syenite (Calcite)	