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Trace-element distribution around a south Texas roll-type uranium deposit

by

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Abstract

The distribution of trace elements around a south Texas roll-type uranium deposit was examined using semiquantitative emission spectroscopic analytical data complemented by some quantitative data. The results suggest that of the 50 elements analyzed, only beryllium and possibly vanadium are enriched in the altered rock on the updip side of the deposit.

Introduction

The aim of this study was to develop prospecting guides for roll-type uranium deposits through the recognition of patterns in the distribution of trace elements around these deposits. Harshman (1974) summarized the trace-element-distribution data acquired around six roll-type uranium deposits. His samples were confined to within several tens of meters of the deposits and, although his data are very useful in understanding the genesis of these deposits, the narrow spread of his samples restricts the application of his data in prospecting.

The deposit studied here is a roll-type deposit in Webb County, Tex. This deposit was chosen partly because of the wide distribution of samples around the ore. Cores were available for nearly a kilometer to either side of the deposit; thus, the distance at which trace-element distributions could be studied was extended beyond the limits imposed on Harshman's study. Furthermore, studies relating to the genesis of this deposit (Reynolds and Goldhaber, 1978; Goldhaber and others, 1978) provide an essential framework for the development of prospecting guides.

All of the samples used in this study were from cores of sandstone. Twenty-one samples of whole rock were analyzed; 10 of these were from oxidized rock updip of the ore, and 11 were from reduced rock downdip of the ore. Their locations relative to the ore are plotted in figure 1. Sixteen samples from the fine (less than 44 micrometers) fraction were studied; eight were from oxidized rock and eight from reduced rock. Their locations are shown in figure 2.

A semiquantitative analysis for 50 elements was made for each of the samples by emission spectroscopy. This technique has the advantage of providing data on many elements even with a very limited amount of sample--a restriction for some of these samples. The analytical results (table 1, whole-rock samples; table 2, <44 μm fraction) for each element were plotted according to the relative positions of the samples; figure 3 is such a plot for molybdenum. Inspection of these plots of semiquantitative data suggests that beryllium, copper, molybdenum, niobium, nickel, and vanadium might have systematic distributions around the ore. Quantitative emission spectrographic analyses were obtained for copper, nickel, and vanadium (tables 1 and 2). Because the concentrations of beryllium and niobium in most of the samples were below the detection limits of quantitative spectrographic techniques (which require dilution of the sample), this type of analytical data could not be obtained for these elements. In order to verify the patterns of distribution observed for beryllium and niobium, and to remove any possible bias on the part of the analyst, the spectrographic plates were reread (semiquantitatively) for these elements by a second analyst. (The results are included in tables 1 and 2 as "second reading.") Extra care was taken in the second reading, which lowered the detection limit of Be from 1.5 to 1 ppm and of Nb from 10 to 7 ppm.

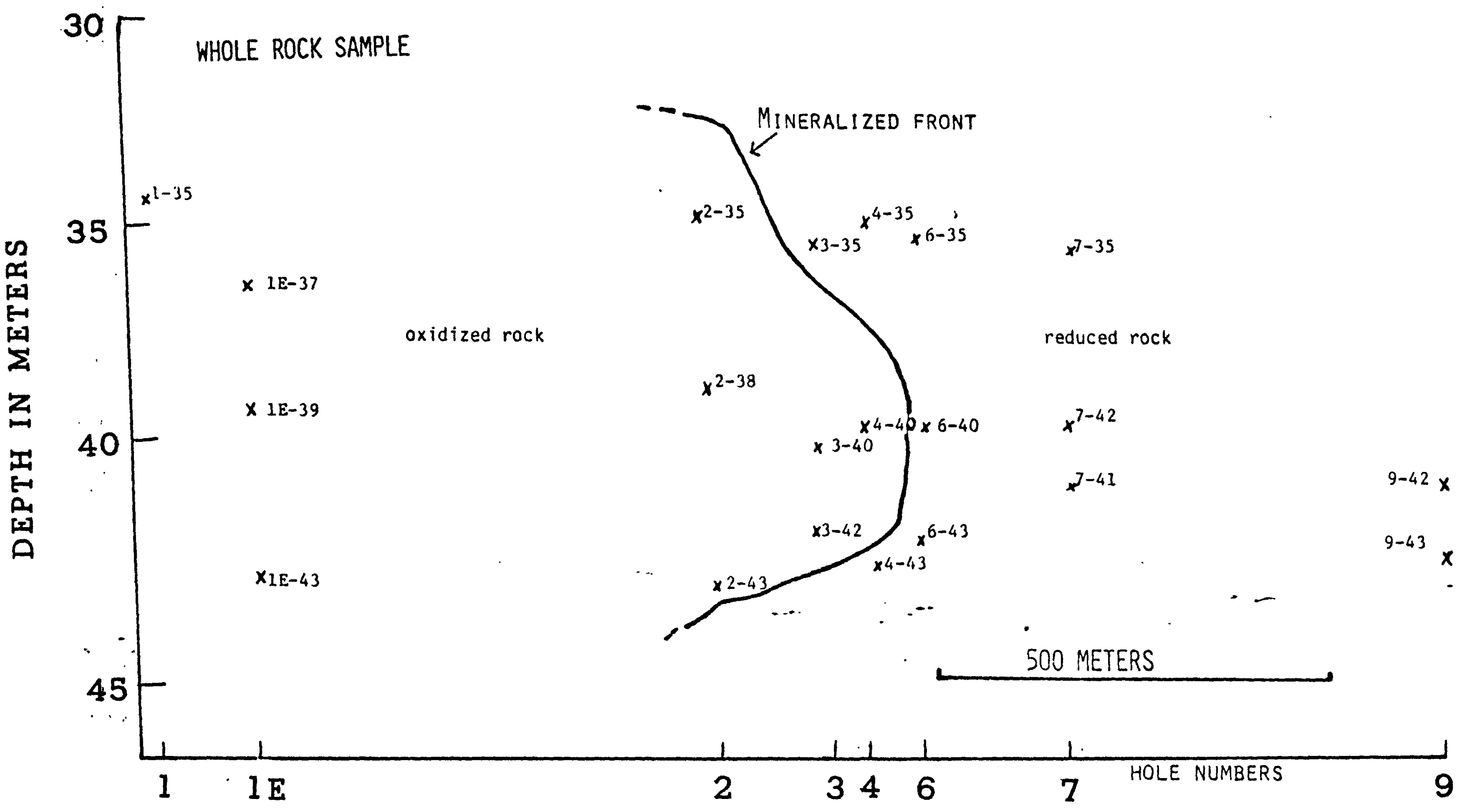

FIGURE 1.- LOCATION OF WHOLE-ROCK SAMPLES.

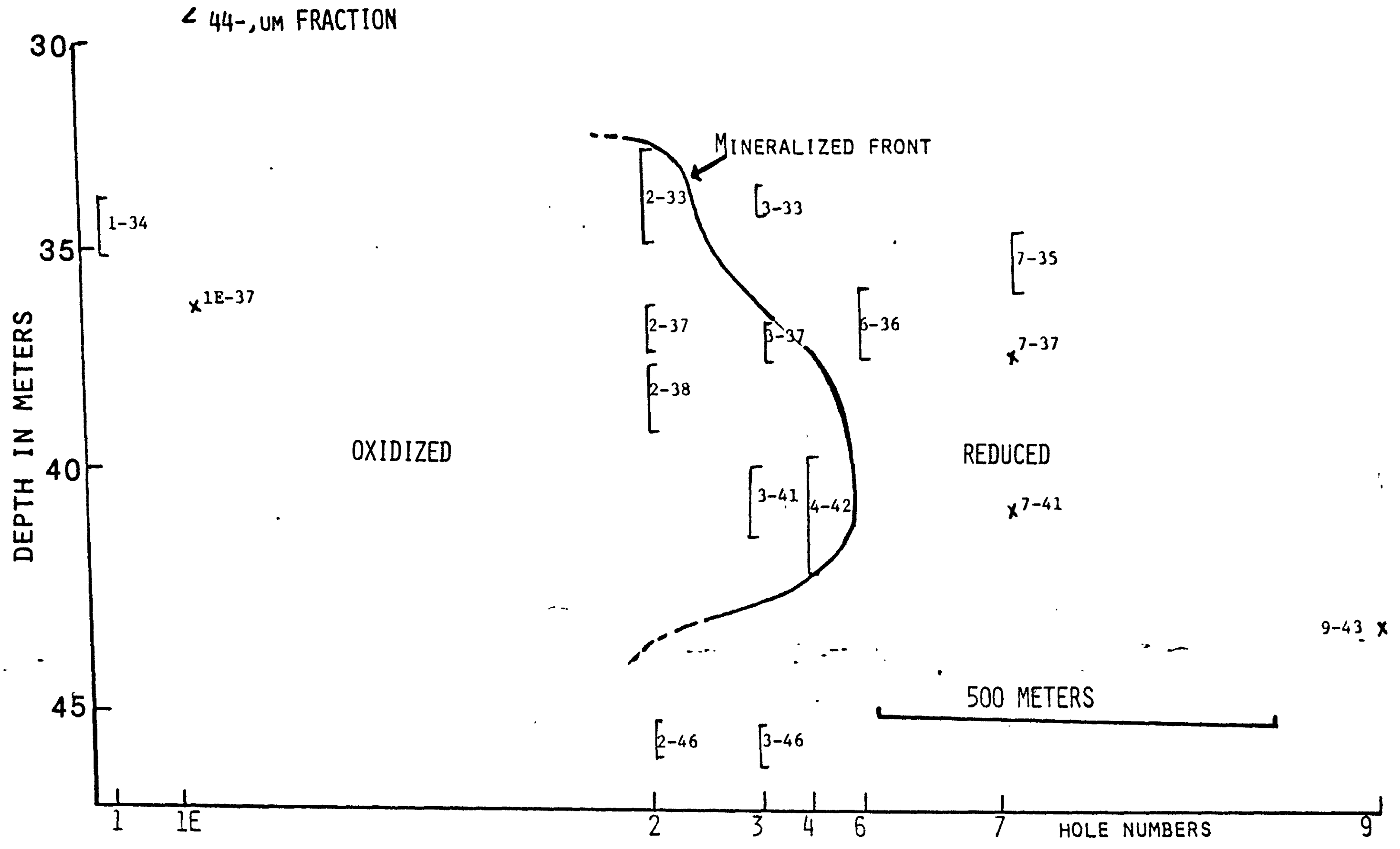

FIGURE 2.-LOCATION OF THE FINE LESS THAN 44 MICROMETER SAMPLES.

Table 1.--Semiquantitative emission spectroscopic data for whole-rock samples in ppm except where stated.

[L = detected but below limit of determination; N = below detection limits. Looked for but not detected in any samples: As, Au, Bi, Cd, Ce, Eu, Ge, Hf, In, Li, P, Pd, Pt, Re, Sb, Sn, Ta, Te, Th, Tl, U, W, or Zn. Detection limits (ppm) for elements not detected in some or all samples: Ag(0.5), As(1000), Au(20), B(20), Be(1.5), Be[1](1.0), Bi(10), Cd(50), Co(5), Eu(100), Ga(5), Ge(10), Hf(100), In(10), La(50), Li(100), Mo(3), Nb(10), Nb[1](7), Ni(4), Pb(10), Pd(2), Pt(50), Re(50), Sb(200), Ta(500), Te(2000), Th(200), Tl(50), U(500), W(100), Zn(300), P(0.2%)]

	Oxidized																Reduced								
	1-35	1E-37	1E-37	1E-39	1E-43	2-35	2-38	2-43	3-40	3-42	4-40	4-40	3-35	4-35	4-43	4-43	6-35	6-40	6-43	7-35	7-41	7-42	7-42	9-42	9-43
Ag	N	N	N	0.7	N	N	N	N	N	N	N	N	N	N	N		N	N	N	N	N	N		N	N
B	30	L	30	30	20	30	30	30	30	30	30	30	30	30	L		30	20	20	L	L	20		L	30
Ba	500	1000	1500	500	300	300	500	300	500	300	300	500	500	300	300		300	500	300	300	500	300		300	500
Be	1.5	N	1.5	N	N	N	1.5	N	1.5	1.5	1.5	1.5	N	N	N		N	N	N	N	N	N		N	N
Be[1]	1	N	1	N	N	N	1	1.5	1	1.5	1	N	N	N	N	N	N	N	N	N	N	1	N	N	N
Co	7	L	L	L	L	L	L	L	L	L	L	L	L	L	L		L	5	L	L	L	L		L	L
Cr	50	15	15	20	15	30	15	20	15	15	15	15	30	20	15		15	15	20	20	15	15		20	15
Cu	15	15	20	15	7	15	15	15	7	15	10	7	15	7	15		15	7	15	7	7	15		15	10
Cu[2]	10	10	15	9	7	9	8	9	5	8	6	6	7	10	11	10	9	5	7	7	6	8	10	11	5
Ga	20	15	15	15	15	15	15	15	15	20	15	15	15	15	15		15	15	15	15	15	15		15	15
La	L	N	L	N	N	N	L	N	N	N	N	N	N	N	N		N	N	N	N	N	N		N	N
Mn	500	300	300	500	300	300	300	300	500	300	700	700	300	500	500		500	700	500	300	300	300		500	300
Mo	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N	N	N	3	30	3		N	N
Nb	10	10	10	10	10	10	L	10	N	10	10	L	10	L	N		L	L	L	N	L	L		10	L
Nb[1]	15	15	10	15	10	10	15	10	N	15	15	10	10	10	7	15	10	10	10	N	10	10	10	15	10
Ni	10	5	5	7	5	7	5	7	5	5	5	5	5	5	L		5	5	5	5	L	5		5	5
Ni[2]	6	4	4	7	4	4	4	5	6	5	5	6	4	6	6	6	5	5	4	6	N	5	6	7	5
Pb	15	15	15	15	15	15	15	20	15	15	15	15	15	15	15		15	15	15	15	15	150		10	15
Sc	7	5	7	7	7	7	7	7	7	7	7	7	5	7	5		7	5	7	7	7	7		5	7
Sr	500	500	500	500	300	300	500	500	500	500	500	500	500	500	300		300	500	500	700	500	300		300	300
V	100	50	70	70	50	70	100	50	70	70	50	50	50	50	30		70	30	50	70	70	50		50	70
V[2]	90	50	60	100	60	100	120	50	60	60	50	60	40	60	80	70	60	60	60	60	50	60	70	60	70
Y	20	15	15	15	15	15	15	15	20	20	30	20	15	15	15		15	15	15	15	15	15		10	20
Yb	2	1.5	1.5	2	1.5	1.5	1.5	2	1.5	1.5	3	1.5	1.5	1.5	1.5		1.5	1.5	1.5	1.5	1.5	1.5		1.5	1.5
Zr	200	70	70	100	100	70	150	150	100	70	150	100	70	70	70		150	150	70	70	100	100		50	150
Fe%	3	1.5	2	2	1.5	1.5	2	2	1	1.5	1.5	1	1.5	1.5	1		2	1.5	1.5	1.5	3	2		1.5	1.5
Mg%	.7	.2	.3	.3	.3	.5	.5	.5	.3	.5	.3	.5	.3	.3	.3		.3	.3	.3	.3	.2	.3		.3	.3
Ca%	10	7	7	10	7	7	7	10	10	10	10	10	10	10	7		10	10	10	>10	10	10		7	10
Ti%	.3	.2	.3	.3	.15	.2	.3	.3	.2	.15	.2	.2	.2	.15	.15		.2	.15	.2	.2	.2	.2		.2	.2
Al%	10	7	10	7	7	7	10	7	10	7	10	10	7	10	7		7	7	7	7	7	7		7	7
Na%	3	3	3	3	2	3	3	3	3	3	3	2	3	2	3		3	3	3	3	2	3		3	3
K%	3	1.5	1.5	1.5	1.5	1.5	1.5	2	1.5	1.5	1.5	1.5	1.5	3	1.5		1.5	2	1.5	2	1.5	1.5		1.5	2

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[1] Second reading.

[2] Quantitative emission spectroscopic data.

Table 2.--Semiquantitative emission spectroscopic data for 44-μm fraction, in ppm except where stated.

[L = detected but below limit of determination; N = not detected. Looked for but not detected in any samples: As, Au, Bi, Cd, Ce, Eu, Ge, Hf, In, Li, P, Pd, Pt, Re, Sb, Ta, Te, Th, Tl, U, W, or Zn. Detection limits (ppm) for elements not detected in some or all samples: Ag(0.5), As(1000), Au(20), B(20), Be(1.5), Be^1(1.0), Bi(10), Cd(50), Co(5), Eu(100), Ga(5), Ge(10), Hf(100), In(10), La(50), Li(100), Mo(3), Nb(10), Nb^1(7), Ni(4), Pb(10), Pd(2), Pt(50), Re(50), Sb(200), Ta(500), Te(2000), Th(200), Tl(50), U(500), W(100), Zn(300), P(0.2%)]

	Oxidized											Reduced									
	1-34	1E-37	1E-37	2-33	2-33	2-37	2-38	3-37	3-41	3-41	4-42	2-46	3-33	3-46	6-36	7-35	7-35	7-37	7-41	9-43
Ag	N	N	N	N	N	N	N	N	1	N	N	N	N	N	N	N	N	N	N	N
B	20	L	L	20	20	20	L	L	L	L	50	20	20	30	50	1	L	L	L	20
Ba	200	700	700	200	200	200	200	150	200	150	150	200	200	200	200	150	150	150	150	200
Be	N	N	N	N	N	N	N	N	N	N	N	L	N	L	N	N	N	N	N	N
Be^1	N	N	N	N	N	N	N	N	N	N	N	1	N	1.5	N	N	N	N	N	1
Co	5	L	L	L	L	L	5	5	L	L	5	L	5	5	5	L	L	L	L	L
Cr	30	30	30	50	30	50	30	30	50	30	150	30	50	30	70	20	30	20	30	30
Cu	30	100	70	50	50	30	100	50	100	70	200	30	30	30	200	50	50	20	50	50
Cu^2	31	120	88	62	56	36	180	30	150	200	440	35	34	29	790	38	41	34	46	34
Ga	10	7	7	7	7	7	7	7	10	7	10	10	10	10	10	7	7	7	7	10
La	N	N	N	L	N	L	N	L	L	N	L	L	N	N	L	N	N	N	N	N
Mn	500	500	700	500	500	700	500	700	700	700	500	300	700	200	300	500	500	700	500	300
Mo	N	N	N	N	N	N	N	N	N	N	N	N	N	5	L	N	N	N	20	L
Nb	N	L	N	N	N	N	N	N	N	L	L	L	N	L	L	N	N	N	L	L
Nb^1	10	10	N	7	N	10	10	N	7	10	15	15	10	15	10	7	7	N	7	10
Ni	10	5	7	7	7	7	7	7	7	7	50	7	10	10	50	5	5	5	5	7
Ni^2	14	12	9	10	10	12	12	8	13	12	81	12	13	15	73	10	7	7	10	12
Pb	L	10	10	20	20	15	L	10	10	10	15	10	L	10	70	10	10	15	15	10
Sc	10	10	7	10	10	10	10	10	10	10	7	10	7	7	5	5	5	10	10	17
Sn	N	L	L	N	N	N	N	N	N	N	L	N	N	N	15	N	N	N	N	N
Sr	300	500	300	200	300	500	300	300	500	300	150	300	300	200	200	300	300	300	300	300
V	100	100	70	150	150	200	200	150	100	70	70	70	150	70	70	70	70	70	100	70
V^2	120	110	90	170	160	180	220	120	110	100	150	130	130	110	100	110	80	110	140	90
Y	10	10	10	10	10	15	10	10	10	10	15	10	10	15	15	L	L	10	10	10
Yb	1	1	1	1	1	1.5	1	1	1	1	5	1.5	1	1.5	3	L	L	1	1	1
Zr	100	70	70	70	100	100	70	50	70	70	1000	70	100	100	700	70	70	50	70	100
Fe%	2	2	2	2	2	2	3	3	3	2	3	1.5	2	3	3	1.5	2	2	2	2
Mg%	.5	.5	.5	.5	.5	.3	.3	.3	.5	.5	.5	.7	.7	.7	.5	.5	.7	.3	.5	.7
Ca%	10	>10	>10	10	10	>10	>10	>10	>10	>10	7	7	10	7	5	>10	>10	>10	10	7
Ti%	.2	.2	.15	.3	.3	.3	.3	.3	.2	.2	.3	.2	.3	.3	.3	.2	.2	.3	.3	.2
Si%	>10	>10	10	>10	>10	10	10	10	>10	10	>10	>10	>10	>10	>10	7	10	7	>10	>10
Al%	7	7	7	7	7	7	7	7	7	7	7	10	10	10	5	5	5	5	7	7
Na%	1	2	1	1	1	1	1	1	1	1	1	1	1	.7	1	.7	1	.7	1	1
K%	1.5	1.5	2	1.5	2	1.5	2	1.5	2	2	2	2	2	2	2	1.5	1.5	1.5	1.5	2

[1] Semiquantitative emision spectroscopic data, second reading.

[2] Quantitative emission spectroscopic data.

These semiquantitative data are presented as the midpoints of geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, and 0.12. Thus, there are six brackets for every order of magnitude. The boundaries for higher or lower values are the same as these, except for the position of the decimal. The precision of a reported value is approximately plus-or-minus one bracket at the 68-percent confidence level or plus-or-minus two brackets at the 95-percent confidence level.

The results in tables 1 and 2 include "blind" splits of samples 1E-37, 2-33, 3-41, 4-40, 4-43, 7-35, and 7-42.

Results and discussion

About half of the elements analyzed had concentrations below the detection limits of spectrographic techniques in all or most of the samples. (These undetected elements are listed as headnotes of tables 1 and 2.) Those undetected elements for which spectrographic analysis is a sensitive technique (low detection limit) clearly are of little or no use in prospecting, in that the data confirm the very low concentration of such elements around the ore. Consequently, even if any of these elements are systematically distributed around the ore, the pattern is so subtle that it is unlikely to be of any practical use. Other elements were not detected because of low sensitivity (high detection limit) of spectrographic analysis with respect to these particular elements. Lack of a sufficient quantity of sample prohibited the use of more sensitive analytical techniques, and the utility of these elements as prospecting guides could not be determined from these data. Most of the elements that were within the detection limits were found not to have a systematic distribution around the ore.

Molybdenum has been detected by semiquantitative techniques only in samples approximately 300 meters downdip of the ore (fig. 3). Similar concentrations of molybdenum downdip of the ore have been observed by Harshman (1974) and appear to be typical of roll-type uranium deposits.

Although the semiquantitative data suggest that nickel and copper might be enriched in the altered rock, the quantitative data indicate no significant difference in the concentrations of these elements between oxidized and reduced rock around this deposit. The suggested difference appears to be a product of the large uncertainty of semiquantitative data. In both semiquantitative and quantitative analytical results, for both the whole-rock samples and the less-than-44-micrometer fraction, vanadium has a higher average concentration in the samples updip of the deposit (oxidized rock) than in samples downdip of the deposit (reduced rock). The variation in the concentration of vanadium is so large, however, that a statistical treatment (a modified "t" test) suggests that all of the samples could be from one population rather than representing two populations that have distinctly different concentrations of vanadium. Thus, for these samples, the higher average vanadium concentration updip of the ore is suggested but not statistically verified, and more work on this or other deposits will be required to establish the validity of the suggested relationship.

The distribution of beryllium around this deposit is particularly interesting. In the first set of semiquantitative data (fig. 4) beryllium was detected in 6 out of the 10 whole-rock samples on the updip (oxidized) side of the deposit but in none of the samples on the downdip (reduced) side. In the second reading of the same plate (fig. 5), beryllium was recorded in 7 of the 10 samples updip and in only one of the 11 samples downdip. From these data, beryllium appears to be enriched in the oxidized rock and, although the data are limited, they suggest that this enrichment persists to as much as 800 m updip of the ore. In two of six deposits

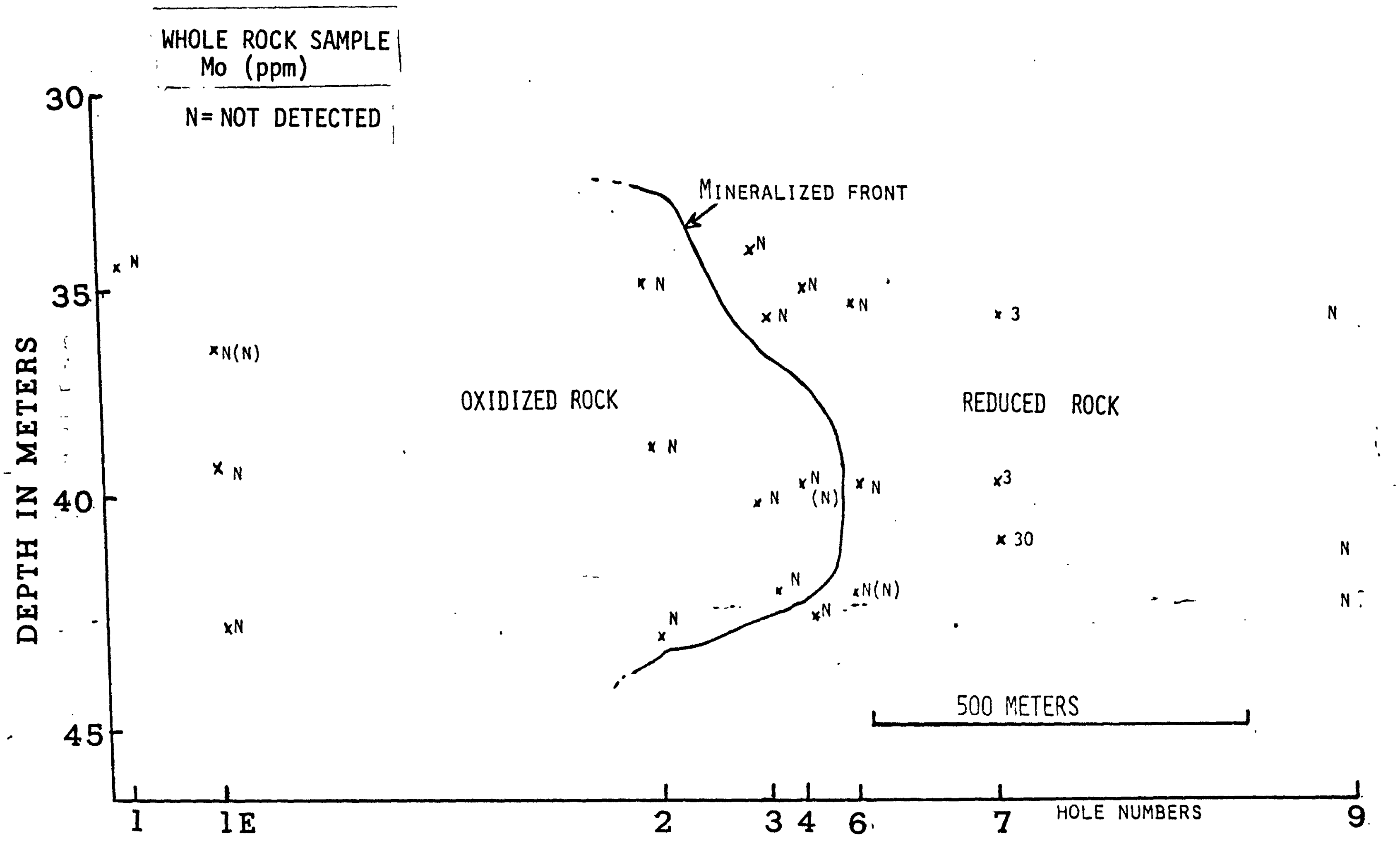

FIGURE 3.-CONCENTRATION OF Mo (PPM) PLOTTED ACCORDING TO THE RELATIVE POSITIONS OF THE SAMPLES. DATA IN PARENTHESES REPRESENT DUPLICATE SAMPLES.

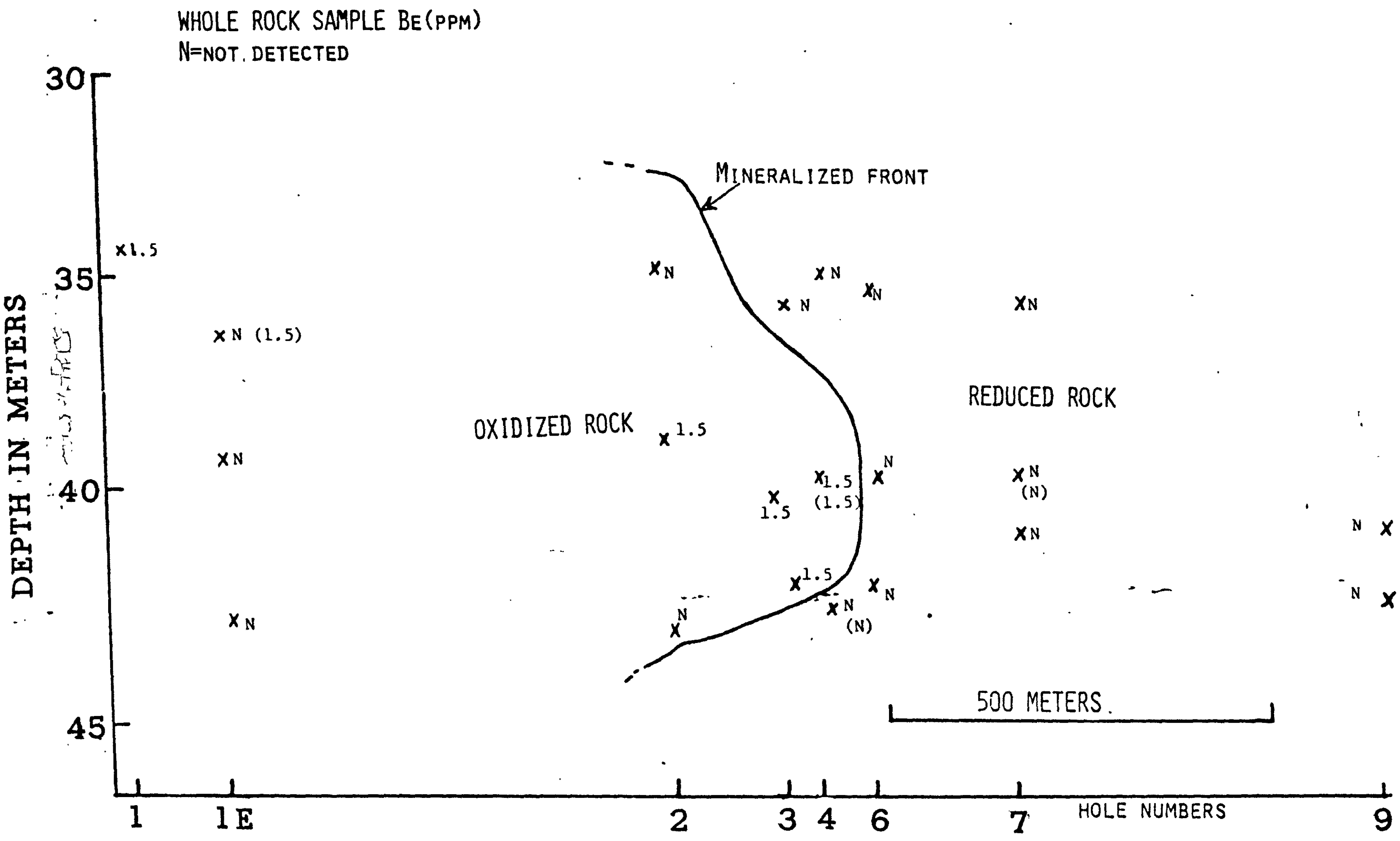

FIGURE 4.-CONCENTRATIONS OF BERYLLIUM (PPM) PLOTTED ACCORDING TO THE RELATIVE POSITIONS OF THE SAMPLES. DATA IN PARENTHESES REPRESENTS DUPLICATE SAMPLES.

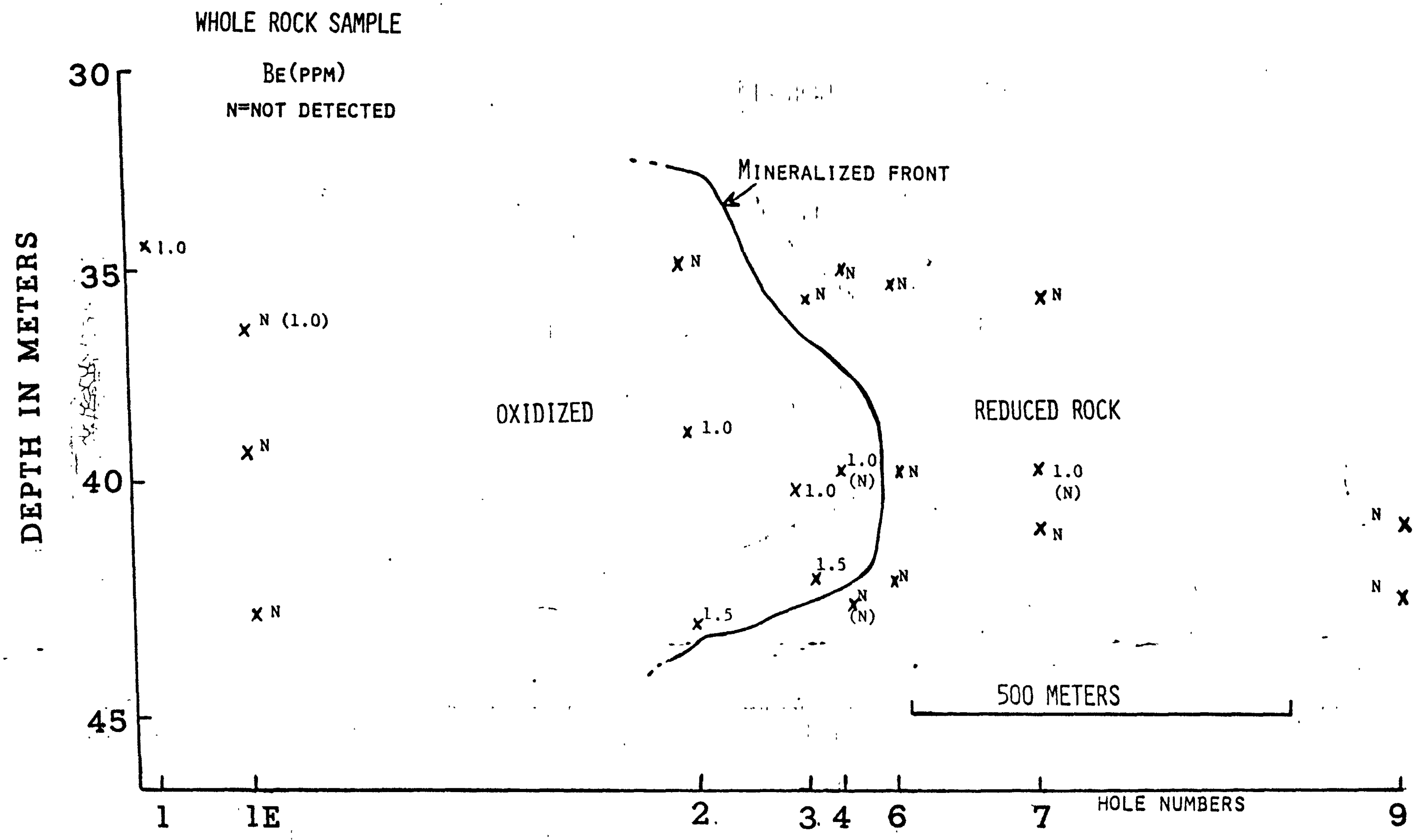

FIGURE 5.-CONCENTRATION OF BERYLLIUM (PPM) PLOTTED ACCORDING TO THE RELATIVE POSITIONS OF THE SAMPLES. DATA IN PARENTHESES REPRESENT DUPLICATE SAMPLES. DATA FROM SECOND READING OF SPECTROGRAPHIC PLATES.

previously studied (Harshman, 1974; greater detail for one of these deposits is provided by Harshman, 1972), beryllium was found to be concentrated in the ore zone. Harshman concluded that beryllium was transported in the ore-forming solution but did not appear to be enriched in the oxidized rock. Beryllium may be enriched in the oxidized rock updip of the deposits studied by Harshman, but at a level too low to be detected by spectroscopic analysis. It is also possible that the ore-forming processes for the deposit studied in this report were slightly different in time or character from the processes for those studied by Harshman. In either case, beryllium does appear to be systematically distributed around this deposit and the presence of beryllium in oxidized rock might be an indicator of this type of uranium deposit.

References

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