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Statistical treatment and preliminary interpretation of chemical data from a uranium deposit in the northeast part of the Church Rock area, Gallup mining district, New Mexico

by

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Contents

Illustrations

Table

Abstract

Statistical treatment of analytical data from 106 samples of uranium-mineralized and unmineralized or weakly mineralized rocks of the Morrison Formation from the northeastern part of the Church Rock area of the Grants uranium region indicates that along with uranium, the deposits in the northeast Church Rock area are enriched in barium, sulfur, sodium, vanadium and equivalent uranium. Selenium and molybdenum are sporadically enriched in the deposits and calcium, manganese, strontium, and yttrium are depleted. Unlike the primary deposits of the San Juan Basin, the deposits in the northeast part of the Church Rock area contain little organic carbon and several elements that are characteristically enriched in the primary deposits are not enriched or are enriched to a much lesser degree in the Church Rock deposits. The suite of elements associated with the deposits in the northeast part of the Church Rock area is also different from the suite of elements associated with the redistributed deposits in the Ambrosia Lake district. This suggests that the genesis of the Church Rock deposits is different, at least in part, from the genesis of the primary deposits of the San Juan Basin or the redistributed deposits at Ambrosia Lake.

Introduction

This paper summarizes the chemical abundance of 106 samples of mineralized and unmineralized sandstone collected by Fishman and Santos from the Kerr-McGee Corporation's Church Rock no. 1 and no. 1 East uranium mines. The mines are located in the western part of the Gallup Mining district which is one of several mining districts in the Grants uranium region of New Mexico (fig. 1). Uranium mineralization at the Church Rock deposits occurs mainlyin the upper part of the Westwater Canyon Member of the Morrison Formation of Late Jurassic age.

Radiometric age determinations indicate that the Church Rock ores are predominately Pleistocene in age with minor remnants of Mesozoic and Tertiary mineralization (Ludwig and others, 1982). Such ages lend support to contentions that the deposits formed from the redistribution of uranium from preexisting primary (tabular) uranium deposits. It is believed that the redistribution process began in the late Tertiary and has continued to the present (Saucier, 1980). The redistributed uranium deposits in the Ambrosia

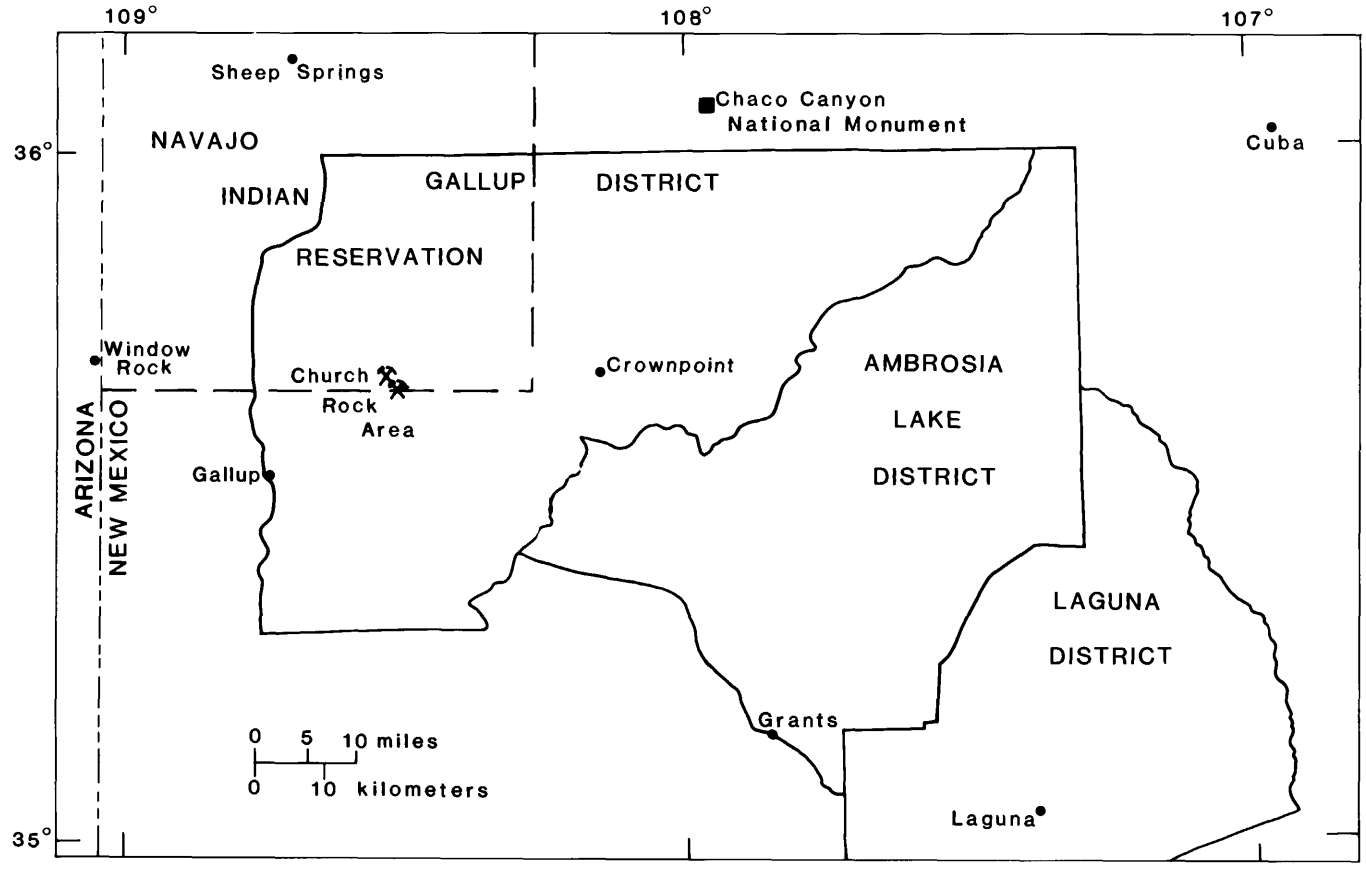

Figure 1.--Index map, Church Rock area, Grants uranium region.

Lake area are typically late Tertiary in age (Ludwig, 1982); thus they are older than most of the Church Rock deposits. In addition to being younger, the Church Rock ores also display some different mineral characteristics from the redistributed ores in the Ambrosia Lake area. Pyrite, for example, is much more abundant in the redistributed deposits in the Ambrosia Lake area than in the deposits in the northeast part of the Church Rock district (Santos, oral commun., 1982). Thus the ore-forming processes in the Church Rock area may have been somewhat different from those that formed the redistributed ore bodies in the Ambrosia Lake area.

Method of study

All of the samples were analyzed for uranium by delayed neutron analysis and for 42 other elements by inductively-coupled argon-plasma-atomic-emission-spectrometry (ICP). The latter technique is described by Fassel and Kniesley (1974) and Taggart and others (1981). Precision and accuracy of the ICP technique is about plus-or-minus 10% or better (J. Crock, oral commun., 1982). Twenty samples were also analyzed for selenium by X-ray fluorescence and for equivalent uranium (eU) by using a Geiger counter. Eighty-six samples were analyzed for sulfur, organic carbon, and inorganic carbon by a process which involves combustion of the sample and measurement of CO_2 or SO_2 gas. Of the 42 elements analyzed by ICP, the following were not detected in any of our samples at the limits of determination noted in parentheses after each element: Au (10 ppm), Bi (10 ppm), Cd (2 ppm), Nb (5 ppm), Sn (5 ppm), Eu (4 ppm), Tb (50 ppm), Ho (3 ppm), and Er (5 ppm). The elements Pr, Sm, Dy, Sc, and Gd were rarely detected at limits of 5 ppm, 4 ppm, 5 ppm, 3 ppm, and 5 ppm, respectively. Limits of determination for elements that were detected more than rarely are included in Table 1. Some of these limits of determination are different from those of emission spectrographic techniques used in an earlier study (Spirakis, Pierson, and Granger, 1981). For this reason, comparison of some elements is difficult or impossible.

As a first step in determining the chemical characteristics of the deposits in the northeastern part of the Church Rock area, the samples used in this study were divided into three groups: highly mineralized, mineralized, and weakly mineralized or unmineralized. Highly mineralized rocks were arbitrarily defined as those containing more than 1000 ppm uranium;

mineralized rocks (which include the highly mineralized rocks) were defined as those containing more than 100 ppm uranium, and unmineralized or weakly mineralized rocks were defined as those with less than 100 ppm uranium. Of the 76 samples that contain more than 100 ppm uranium, 51 contain more than 1000 ppm uranium. The unmineralized or weakly mineralized group contains 30 samples. With the aid of a computer, the geometric mean and geometric deviation of each of the elements in each of the three groups were computed; these statistical results are included in Table 1.

In a number of samples, certain elements were not detectable (N) or were present in an amount less than the lower limit of determination (L) for that element. N's and L's are referred to as qualified values, and a data set containing them is said to be censored on the left. The Church Rock data (table 1) contain no qualified values greater than the upper limit of determination (G) for any element, and are therefore singly censored.

For singly censored data, a method devised by Cohen (1959, 1961) and later computerized by VanTrump (1978) was used to estimate geometric means and deviations for those elements whose analyses contain qualified values. In this procedure, N's are not distinquished from L's and log normality for the data is assumed. The geometric means and deviations, which should be considered as estimates, are calculated from functions of the following quantities: 1) geometric means and deviations of the unqualified values; 2) the numerical value of the limit of determination; and 3) the number of qualified values in the data.

A "t" test described by Natrella (1963) was used to identify statistically significant differences between geometric means of elements in the mineralized and unmineralized groups. On the basis of these tests, it was determined that at a 95% confidence level, barium, sulfur, sodium, vanadium, uranium and equivalent uranium (eU) are enriched in the mineralized samples compared to the unmineralized or weakly mineralized rock in the Church Rock area. Beryllium, cobalt, selenium, and molybdenum also appear to be enriched but because of a high proportion of N and L values in the data, no statistical test could be made. A few very high values of molybdenum (up to 855 ppm) and of selenium (up to 200 ppm) indicate that these elements are indeed enriched in some ore samples. The rarity of these high values suggests that the

enrichment is sporadic and that these elements are not uniformly distributed throughout the ores. The statistical tests indicate that calcium, manganese, strontium, and yttrium, are depleted in the mineralized rock compared to adjacent unmineralized rock. Because of the large number of L values in the data, the possible depletion of nickel could not be tested. No statistically significant differences (at the 95% confidence level) were found between mineralized and unmineralized rock in the Church Rock district in the abundances of lithium, potassium, magnesium, lanthanum, cerium, thorium, neodymium, iron, copper, zinc, gallium, aluminium, lead, organic carbon and inorganic carbon. These results are summarized on figure 2.

Discussion

If the deposits of the northeastern part of the Church Rock area formed from an oxidation and redistribution of preexisting primary uranium deposits as suggested by Adams and Saucier (1980), then a comparison of the chemical characteristics of the Church Rock deposits to the chemical characteristics of the organic-rich, primary deposits at Ambrosia Lake (Spirakis, Pierson, and Granger, 1981) and at the Mariano Lake and Ruby mines (C. T. Pierson and C. S. Spirakis, unpub. data, 1983) may provide some clues as to the behavior of elements in the process of redistribution. Some elements, such as Ca, Mn, Sr, and Y are depleted in the deposits of the Church Rock district compared to unmineralized or weakly mineralized rock but are enriched in the organic-rich, primary deposits. Other elements, including Cu, Fe, Mg, and Pb are enriched in the primary ores of Ambrosia Lake, Ruby and Mariano Lake but show no significant change in their abundances in the deposits of the Church Rock district compared to the adjacent unmineralized rock. Although vanadium and sulfur are enriched in the Church Rock deposits, the concentration of vanadium and sulfur in the Church Rock deposits is a factor of 10 less than in the deposits of the Ambrosia Lake area (Spirakis and Pierson, 1981) or in the Mariano Lake or Ruby deposits (Pierson and others, in preparation). Molybdenum and selenium are sporadically enriched in the Church Rock deposits but are typically enriched in the organic-rich deposits. Thus the behavior of organic carbon, Ca, Cu, Fe, Pb, Mn, Mg, Sr, Y, S, V, Se, and Mo was different in the redistribution process than in the primary ore-forming process. The difference in the behavior of lead may simply be due to the short amount of

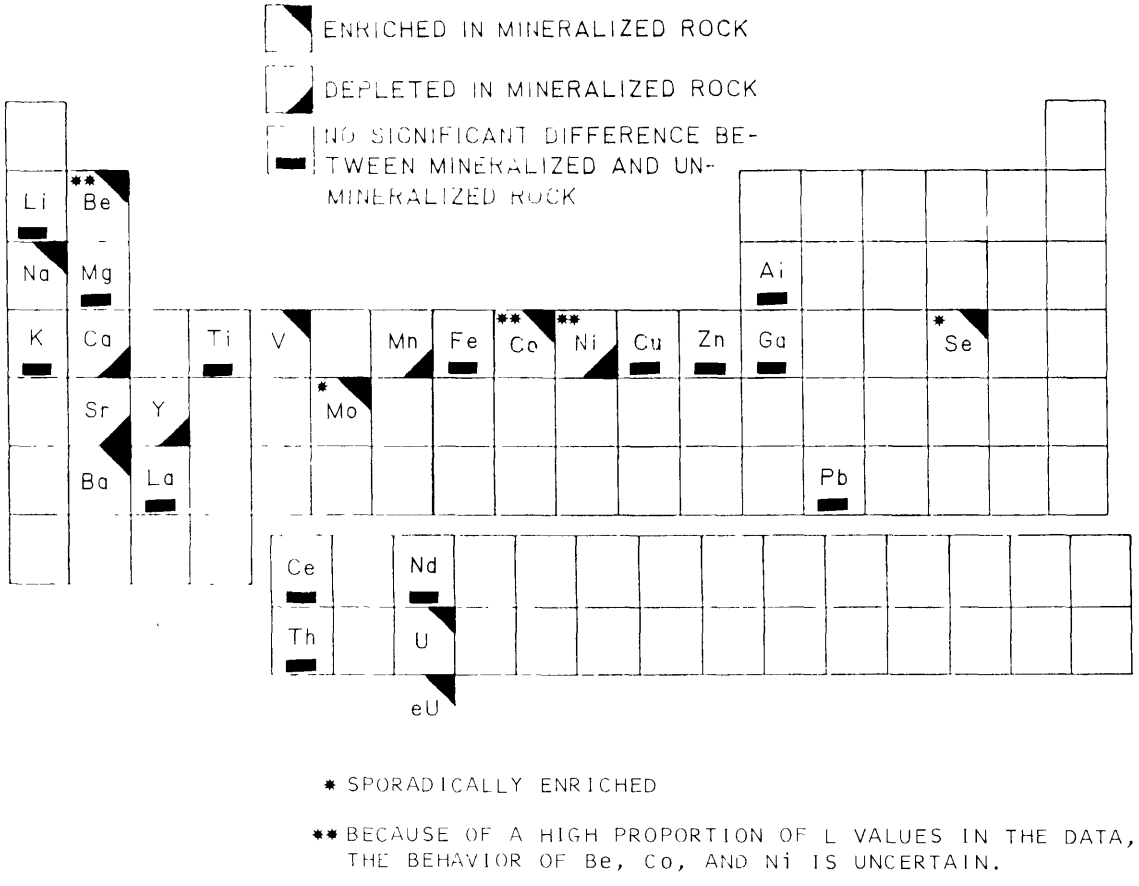

Figure 2.--Chemical characteristics of the Church Rock deposits.

time available to generate radiogenic lead in the Church Rock deposits compared to the older primary deposits. The other elements listed above somehow became separated (to varying degrees) from uranium during the redistribution process.

The Church Rock deposits lie on a regional oxidation front (Saucier, 1980) and the redistribution process is believed to have involved oxidizing solutions that separated uranium from many of the elements (organic carbon, Ca, Cu, Fe, Mn, Mg, Sr, Y, S, V, Se, and Mo) with which uranium was associated in the primary ore (postulated precursor of the Church Rock deposits). The separation might in part be due to differences in the mobility of uranium and other elements under oxidizing conditions. Uranium is well known to be mobile in oxidizing solutions. In contrast, much of the magnesium in the primary ore is immobile due to its incorporation into clay minerals and chlorite. Thus in the redistribution process, oxidizing solutions may have separated uranium from magnesium by mobilizing uranium and leaving magnesium behind. Some of the elements including Ca, Cu, Fe, Mn, S, Se, Sr, and V that were separated from uranium by the redistribution process at Church Rock are the same elements that were concentrated with uranium in the redistributed deposits at Ambrosia Lake. The enrichment of these elements in the redistributed deposits at Ambrosia Lake indicates that these elements are mobile under the oxidizing conditions of the redistribution process and the fact that Ca, Cu, Fe, Mn, S, Se, Sr, and V behaved differently in the Church Rock and Ambrosia Lake redistributed deposits may indicate a difference in the genetic processes that formed the deposits in the two areas. The behavior of elements in the genesis of the Church Rock deposits might be partly obscured by weathering processes that were not related to either the formation of the primary ore or the redistribution of the ore. Data in Beck and others (1980) indicate that pre-Dakota weathering leached a number of elements from the Morrison Formation in the Laguna area. Possibly such weathering contributed to the depletion of calcium, manganese, and strontium from the Church Rock deposits.

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Table 1. -- Data summary of the Church Rock district
* denotes uncertain geometric means

Al%

Determination limit - .05%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	2.4	2.4	2.5
Maximum value	8.5	8.5	8.3
Geometric mean	4.41	4.49	4.43
Geometric deviation	1.22	1.18	1.32
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

Ba ppm

Determination limit - 1 ppm

	Church Rock		
Sample set	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	320	320	400
Maximum value	2500	2500	1100
Geometric mean	802.8	811.1	664.4
Geometric deviation	1.42	1.40	1.26
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

Barium enrichment may be the result of oxidation of pyrite to form sulfate which then combines with barium to precipitate as barite.

Be ppm

Determination limit - 0.8 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	.8	.8	1.0
Maximum value	3.0	3.0	4.0
Geometric mean	1.08*	1.19*	.89*
Geometric deviation	1.32	1.48	2.45
No. of N's	0	0	0
No. of L's	27	42	17
No. of G's	0	0	0

Comments

The difference in geometric means of beryllium in mineralized rock to beryllium in unmineralized rock suggests that beryllium is enriched in the ore. The geometric means, however, are based on sets of samples that contain many L values; thus the geometric means are only estimates and any conclusion based on these estimates is uncertain.

Ca%

Determination limit - .05%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	.090	.090	.078
Maximum value	8.73	8.73	10.00
Geometric mean	.174	.178	.358
Geometric deviation	2.51	2.61	5.12
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

These data indicate that calcium is depleted in the mineralized rock compared to adjacent unmineralized or weakly mineralized rock.

Ce ppm

Determination limit - 15 ppm

	Church Rock		
Sample set	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	15.	15.	15.
Maximum value	80.	88.	97.
Geometric mean	31.9	33.0	31.2
Geometric deviation	1.38	1.39	1.53
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

Co ppm

Determination limit - 1.0 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	1.0	1.0	2.0
Maximum value	7.0	8.0	8.0
Geometric mean	.80*	.72*	.42*
Geometric deviation	2.80	3.12	6.14
No. of N's	0	0	0
No. of L's	30	47	21
No. of G's	0	0	0

Comments

*As with beryllium, the geometric means suggest an enrichment of cobalt in the mineralized rock compared to unmineralized rock but the geometric means are based on sample suites that contain many "L" values. Thus, the geometric means are only estimates and the conclusions are uncertain.

Cr ppm

Determination limit - 2 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	2.0	2.0	5.0
Maximum value	11.	50.	20.
Geometric mean			
Geometric deviation			
No. of N's	0	0	0
No. of L's	24	34	15
No. of G's	0	0	0

Comments

In most data sets, values of chromium below the limit of determination are unusual. In these data, almost half of the chromium values are presented as less than 10 ppm even though values as low as 2 ppm are included. Consequently, the geometric means of chromium in these data cannot be accurately estimated.

Cu ppm

Determination limit - 2 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	2.0	2.0	2.0
Maximum value	23.	23.	20.
Geometric mean	4.34	4.39	5.53
Geometric deviation	1.75	1.72	2.12
No. of N's	0	0	0
No. of L's	0	2	3
No. of G's	0	0	0

Comments

Data from the Ambrosia Lake area (Spirakis, Pierson, and Granger, 1981) and from the Ruby and Mariano Lake deposits (Pierson and others, unpublished data) indicate that copper is typically enriched in primary uranium-vanadium deposits in the Morrison Formation of the San Juan Basin. These data, however, indicate that copper is not enriched in the deposits of the northeast Church Rock area.

Fe%

Determination limit - .05%

	Church Rock		
Sample set	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	.38	.38	.33
Maximum value	3.9	3.9	4.3
Geometric mean	.706	.736	.895
Geometric deviation	1.62	1.74	2.23
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

These data indicate no statistically significant difference between iron in mineralized and unmineralized rocks. Primary uranium deposits in the Morrison Formation of the San Juan Basin are typically enriched in iron (Spirakis, Pierson, and Granger, 1981; Pierson and others, unpublished data).

Ga ppm

Determination limit - 5 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	5.0	5.0	6.0
Maximum value	20.	50.	30.
Geometric mean	5.87*	5.85*	4.90*
Geometric deviation	2.35	2.42	2.77
No. of N's	0	0	0
No. of L's	24	35	16
No. of G's	0	0	0

Comments

*Because of the large numbers of "L" values in these data, the geometric means should be considerd as estimates.

K%

Determination limit - .1%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	1.4	1.4	1.4
Maximum value	5.5	5.5	4.3
Geometric mean	2.49	2.52	2.33
Geometric deviation	1.26	1.25	1.31
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

La ppm

Determination limit - 2 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	9.0	9.0	7.0
Maximum value	63.	63.	54.
Geometric mean	18.5	18.8	16.9
Geometric deviation	1.43	1.41	1.59
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

Li ppm

Determination limit - 2 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	7	7	8
Maximum value	23	23	26
Geometric mean	11.9	12.2	12.4
Geometric deviation	1.25	1.30	1.46
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

Mg%

Determination limit - .05%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	.08	.08	.1
Maximum value	.46	.65	1.0
Geometric mean	.16	.16	.23
Geometric deviation	1.47	1.56	2.18
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

Mn ppm

Determination limit - 5 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	10	5.0	11
Maximum value	4700	4700	4500
Geometric mean	85.7	81.4	154.3
Geometric deviation	2.70	3.14	5.49
No. of N's	0	0	0
No. of L's	0	1	0
No. of G's	0	0	0

Comments

These data indicate that manganese is depleted in the northeast part of the Church Rock ore deposit area compared to adjacent unmineralized rocks.

Mo ppm

Determination limit - 3 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	6	6	
Maximum value	591	855	
Geometric mean			
Geometric deviation	304.6	307.	
No. of N's	0	0	
No. of L's	42	63	30
No. of G's	0	0	

Comments

Only 13 of the 76 samples of mineralized rock contain detectable amounts of molybdenum. Therefore, molybdenum is not typically enriched in mineralized rock in the northeastern part of the Church Rock area. The few high values of molybdenum, however, indicate that some isolated concentrations do occur in the ore.

Na%

Determination limit - .1%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	.31	.31	.31
Maximum value	2.1	2.1	1.20
Geometric mean	.96	.96	.67
Geometric deviation	1.29	1.27	1.50
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

These data indicate an enrichment of sodium in the northeast Church Rock deposit area compared to adjacent unmineralized rock.

Nd ppm

Determination limit - 4 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	5.0	5.0	4.0
Maximum value	39	48	49
Geometric mean	14.0	14.4	12.8
Geometric deviation	1.58	1.65	2.03
No. of N's	0	0	0
No. of L's	1	1	2
No. of G's	0	0	0

Comments

Ni ppm

Determination limit - 3 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	3.	3.	4.
Maximum value	13	13	10
Geometric mean	2.8*	2.45*	4.39*
Geometric deviation	2.57	2.83	1.97
No. of N's	0	0	0
No. of L's	28	46	11
No. of G's	0	0	0

Comments

*The data suggest that nickel is depleted in mineralized rock compared to unmineralized rock but the high number of "L" values in the data make the geometric means and the conclusion uncertain.

P%

Determination limit - 0.01%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	.01	.01	.02
Maximum value	.30	.31	.03
Geometric mean			
Geometric deviation	3.59	4.47	2.89
No. of N's	0	0	0
No. of L's	36	53	23
No. of G's	0	0	0

Comments

There are too many L's in these data for the means to be accurately estimated. The similar proportions of L's to total number of analyses in each group suggests that phosphorous is not concentrated or depleted in the Church Rock ores.

Pb ppm

Determination limit - approximately 20 ppm

	Church Rock		
Sample set	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	18	18	14
Maximum value	70	130	40
Geometric mean	20.9	21.4	14.6
Geometric deviation	1.61	1.75	1.69
No. of N's	0	0	0
No. of L's	10	15	13
No. of G's	0	0	0

Comments

These data do not indicate a statistically significant difference in the lead content of mineralized and unmineralized rock. Lack of an enrichment suggests that the deposits are too young to have produced much radiogenic lead. This is in agreement with the age determinations by Ludwig and others (1982).

Total S%

Determination limit - .01%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	40	61	25
Minimum value	.02	.01	.01
Maximum value	.74	.05	.05
Geometric mean	.053	.045	.011
Geometric deviation	2.96	3.14	1.88
No. of N's	0	0	0
No. of L's	1	3	8
No. of G's	0	0	0

Comments

These data indicate an enrichment of sulfur in the mineralized rock.

Se ppm

Determination limit - 0.1 ppm

	Church Rock		
Sample set	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	11	15	5
Minimum value	0.1	0.1	2.1
Maximum value	200	200	2.1
Geometric mean			
Geometric deviation	27.8	19.6	
No. of N's	0	0	0
No. of L's	3	3	4
No. of G's	0	0	0

Comments

The data for selenium are limited but they suggest that, as with molybdenum, isolated concentrations of selenium occur in the ore but selenium is not typically concentrated in ore samples of the Church Rock district. The very high geometric deviations indicate that these data depart markedly from a log normal distribution. Consequently, the geometric means are not accurate.

Sr ppm-S

Determination limit - 2 ppm

	Church Rock		
Sample set	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	75	75	70
Maximum value	220	220	330
Geometric mean	105.9	107.6	130.5
Geometric deviation	1.23	1.25	1.46
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

These data are excellent (no N's or L's) and they indicate a depletion of strontium in the mineralized rock.

Th ppm-S

Determination limit - 4 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	5	4	5
Maximum value	31	31	120
Geometric mean	4.37*	4.36*	2.70*
Geometric deviation	2.91	2.71	4.47
No. of N's	0	0	0
No. of L's	24	42	18
No. of G's	0	0	0

Comments

*Because of the high proportions of L's in these data, the geometric means should only be considered as estimates. Statistical treatment of these estimated geometric means and the similar proportions of L's in suites of mineralized and unmineralized rocks suggest that thorium is neither enriched nor depleted in mineralized rocks.

Ti%-S

Determination limit - .01%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	28
Minimum value	.04	.04	.04
Maximum value	.35	1.35	.33
Geometric mean	.09	.09	.11
Geometric deviation	1.63	1.74	1.74
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

U ppm

Determination limit - .1 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	1030	102	10.5
Maximum value	38,600	38,600	99.3
Geometric mean	3151.7	1487.1	32.4
Geometric deviation	2.14	3.67	1.53
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

eU ppm

Determination limit - .1%

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	11	15	5
Minimum value	370	340	85
Maximum value	2300	2300	720
Geometric mean	1139.6	974.2	292.0
Geometric deviation	1.83	1.90	2.42
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

The difference between these data and the data for uranium indicate that uranium is not in equilibrium with its daughter products.

V ppm

Determination limit - 1 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	25	25	12
Maximum value	1360	1420	107
Geometric mean	127.9	116.6	37.4
Geometric deviation	2.25	2.33	1.70
No. of N's	0	0	0
No. of L's	0	0	0
No. of G's	0	0	0

Comments

Although vanadium is enriched in these mineralized rocks, the geometric mean of vanadium in other deposits in the Grants uranium region is much higher than it is in the Church Rock deposits (Spirakis, Pierson, and Granger, 1981; Pierson and others, unpublished data).

Y ppm

Determination limit - 5 ppm

	Church Rock		
Sample set	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	5.0	5.0	5.0
Maximum value	49.	120.	30.
Geometric mean	6.77	7.16	9.61
Geometric deviation	1.70	1.93	1.79
No. of N's	0	0	0
No. of L's	7	9	2
No. of G's	0	0	0

Comments

These data indicate a depletion of yttrium in the mineralized rock.

Yb ppm

Determination limit - 1 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	1.0	1.0	2.0
Maximum value	8.0	12.	3.0
Geometric mean			
Geometric deviation	2.65	3.70	3.83
No. of N's	0	0	0
No. of L's	38	60	24
No. of G's	0	0	0

Comments

There are too many L's in these data to accurately estimate the geometric means of the sample suites.

Zn ppm

Determination limit - 5 ppm

Sample set	Church Rock		
	G1000 ppm U	G100 ppm U	L100 ppm U
No. of analyses for this element	51	76	30
Minimum value	5.0	5.0	7.0
Maximum value	166	166	71
Geometric mean	15.3	15.8	17.6
Geometric deviation	2.02	1.94	2.14
No. of N's	0	0	0
No. of L's	2	2	0
No. of G's	0	0	0

Comments