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Analytical results and sample locality map of the heavy-mineral concentrates of Lamotte and Reagan Sandstones from Missouri, Arkansas, and Kansas

By

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INTRODUCTION

The Upper Cambrian Lamotte Sandstone and the facies-equivalent Reagan Sandstone are predominantly clean orthoquartzite sandstone. These formations rest directly on the Precambrian basement and are conformably overlain by the Bonnetere Dolomite Formation. They are present in the subsurface throughout Missouri, northern Arkansas, and eastern Kansas, except where locally absent due to paleotopographic highs of the Precambrian surface. The thickness of the sandstones ranges from less than 30 meters in eastern Kansas, northwest Arkansas, and western Missouri to 150 meters in eastern Missouri. Previous studies dealing with the interpretation of the origin of the sandstones and their depositional paleoenvironment have been published by Wallace (1938); Ojakanzas (1963); Houseknecht and Ethridge (1975, 1978); and Yesberger (1982).

The basal sandstones are regarded as a likely aquifer through which basin-derived mineralizing fluids migrated. In their passage, they deposited trace amounts of secondary minerals. Optical emission spectrographic analyses of heavy-mineral concentrates obtained from the basal sandstones provide information on the metal composition of the paleofluids and on the chemistry of detrital minerals which have a direct relationship to the origin of the sandstones. The purpose of this report is to release analytical data for heavy-mineral concentrates of basal sandstones from Missouri, northern Arkansas, and southwest Kansas.

SAMPLING AND ANALYTICAL PROCEDURES

Sandstone samples were collected from the cores of 87 drill holes and from the cuttings of 13 drill holes (Fig. 1). All samples were obtained from the sample libraries of the Missouri, Arkansas, and Kansas State Geological Surveys. Wherever possible, drill holes were selected that penetrated the Lamotte or Reagan Sandstone and bottomed in the Precambrian basement. Forty-eight drill holes met this criterion. For each drill core hole, representative grab samples were obtained at approximately 4-foot intervals and then composited. For drill cutting holes, a representative split was made of each sample interval and then composited. An attempt was made to obtain fairly uniform coverage of the drill hole sites; however, some areas lack drill holes penetrating the basal sandstone.

Because of the extremely low concentration of the metals in raw samples, it was necessary to concentrate the heavy minerals. The samples were first disaggregated with a jaw crusher and sieved through a 0.6-mm screen. The sieved material was then panned, using standard gold-panning techniques, until dark material began to appear at the edges. The samples were then dried, and the heavy minerals were further concentrated by flotation in bromoform. The samples were again dried and any extraneous metal was removed by passing a hand magnet over the sample. The resulting heavy-mineral concentrate is a mixture of detrital minerals and hydrothermally introduced minerals, and is considered analogous to the insoluble-residue sample used by Erickson et al. in evaluating the mineral potential of the carbonate terrane of the Mid-continent (Erickson and others, 1978; 1979; and 1985).

Each concentrate sample was split, and half the sample was hand ground and analyzed for 30 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). The elements analyzed and their lower and upper limits of determination are listed in Table 1. Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure

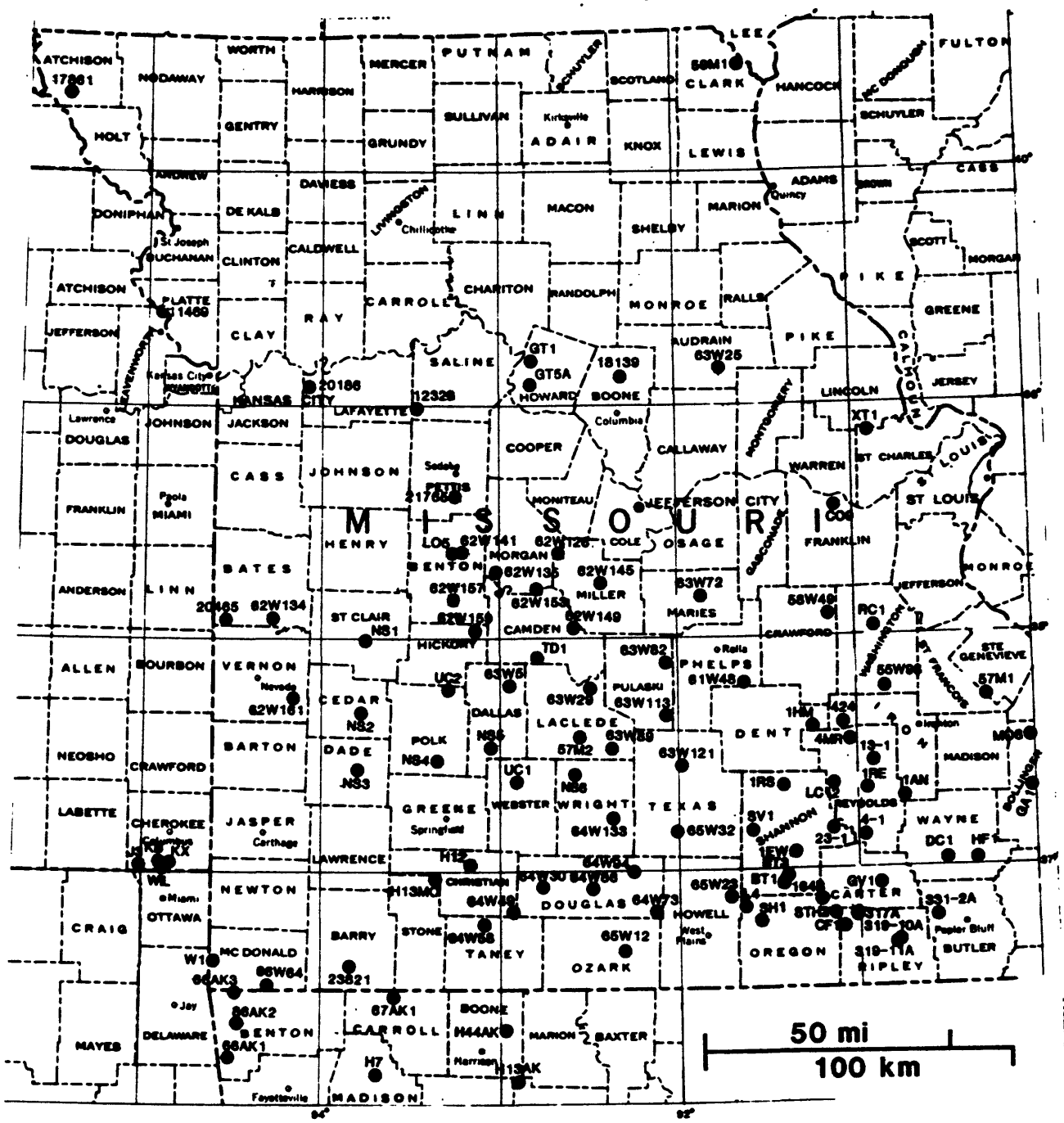

Figure 1. Map showing drill hole locations.

oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, and so forth. The precision of the analytical method is approximately plus or minus one reporting interval at the 83 percent confidence level and plus or minus two reporting intervals at the 96 percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (iron, magnesium, calcium, and titanium) are given in weight percent; all others are given in parts per million (micrograms/gram).

ROCK ANALYSIS STORAGE SYSTEM

Upon completion of all analytical work, the analytical results were entered into a computer-based file called Rock Analysis Storage System (RASS). This data base contains both descriptive geological information and analytical data. Any or all of this information may be retrieved and converted to a binary form (STATPAC) for computerized statistical analysis or publication (VanTrump and Miesch, 1976).

DESCRIPTION OF DATA TABLES

Table 2 lists the analyses for the samples of heavy-mineral concentrate. The data are arranged so that column 1 contains the USGS-assigned sample numbers. These numbers correspond to the numbers shown on the site location maps (Fig. 1). Columns in which the element headings show the letter "s" below the element symbol are emission spectrographic analyses. A letter "N" in the tables indicates that a given element was looked for but not detected at the lower limit of determination shown for that element in Table 1. If an element was observed but was below the lowest reporting value, a "less than" symbol (<) was entered in the tables in front of the lower limit of determination. If an element was observed but was above the highest reporting value, a "greater than" symbol (>) was entered in the tables in front of the upper limit of determination. Because of the formatting used in the computer program that produced Table 2, some of the elements listed in Table 2 (Fe, Mg, Ca, Ti, Ag, and Be) carry one or more nonsignificant digits to the right of the significant digits. The analysts did not determine these elements to the accuracy suggested by the extra zeros.

The spectrographic determinations for Au, Cd, Sb, and W were all below the lower limits of determinations shown in Table 1; consequently, the columns for these elements have been deleted from Table 2. Due to high Zr interference, Sc values were not determined.

Table 1. Limits of determination for the spectrographic analysis, based on a 10-mg sample

[The spectrographic limits of determination for heavy-mineral-concentrate samples are based on a 5-mg sample, and are therefore two reporting intervals higher than the limits given for rocks and stream sediments]

Elements	Lower determination limit	Upper determination limit
	Percent	
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
	Parts per million	
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000

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TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.

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

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s
17861	40 18 45	95 25 0	15	.70	5.00	.10	500	N	200
59M1	40 37 55	91 48 25	15	.70	.50	1.00	1,000	N	N
11469	39 24 5	94 55 40	20	1.00	2.00	.15	1,500	1.0	N
20186	39 4 45	93 57 50	>20	.50	.70	.20	200	2.0	N
12328	38 58 58	93 28 58	20	.50	.50	.15	500	N	N
GT1	39 12 15	92 48 45	7	.30	.20	>1.00	500	N	N
GT5A	39 5 30	92 50 15	10	.07	.05	>1.00	200	N	N
18139	39 6 23	92 17 22	7	.30	.10	1.00	700	N	N
63W25	39 8 44	91 44 52	7	.30	.10	>1.00	500	N	200
XT1	38 52 30	90 53 45	10	.30	.50	>1.00	300	N	N
21765	38 38 10	93 14 30	20	.30	.20	1.00	300	N	N
C09	38 33 40	91 3 52	10	.70	2.00	>1.00	1,000	N	N
L05	38 22 15	93 12 30	20	.15	.10	>1.00	100	N	300
62W141	38 22 25	93 12 16	20	1.00	2.00	.20	500	N	N
62W135	38 17 15	93 1 0	5	5.00	15.00	.20	700	2.0	N
62W126	38 22 45	92 38 10	20	.10	.05	>1.00	100	N	N
62W157	38 11 0	93 14 53	10	1.00	1.00	1.00	1,000	2.0	N
62W153	38 12 21	92 47 45	15	.20	.10	>1.00	300	N	200
62W145	38 14 4	92 25 50	5	2.00	20.00	.10	1,500	3.0	N
63W72	38 10 50	91 51 16	7	.20	.05	1.00	200	N	N
20465	38 5 35	94 31 52	20	.70	.50	.20	500	2.0	200
62W134	38 5 10	94 16 12	10	.30	.10	1.00	1,500	3.0	1,000
NS1	37 59 20	93 44 0	>20	.10	.05	.20	70	N	200
62W159	38 2 26	93 7 45	10	2.00	15.00	.10	700	N	N
62W149	38 2 48	92 33 37	10	2.00	1.00	1.00	3,000	50.0	2,000
TD1	37 55 5	92 50 12	5	.50	.20	>1.00	150	N	200
62W161	37 45 10	94 9 15	7	.50	.20	1.00	500	N	N
NS2	37 40 33	93 46 21	10	.50	.10	.70	500	N	2,000
UC2	37 46 50	93 17 45	5	.15	.05	>1.00	1,000	N	<200
63W5	37 48 15	92 56 16	7	.30	.10	.50	200	N	<200
63W29	37 46 43	92 28 20	10	.50	.15	>1.00	300	2.0	<200
63W82	37 53 15	92 4 3	10	.20	.10	1.00	300	5.0	200
63W113	37 39 45	92 3 30	10	1.00	.30	1.00	1,000	3.0	300
61W48	37 47 50	91 38 50	7	5.00	10.00	.50	2,000	3.0	N
NS3	37 25 33	93 46 17	20	.70	.20	.50	200	2.0	300
NS4	37 27 45	93 21 30	15	1.50	5.00	.30	700	1.0	200
NS5	37 31 0	93 2 35	15	.20	.10	1.00	200	N	2,000
UC1	37 22 20	92 54 0	20	.30	.10	.50	200	2.0	N
NS6	37 24 30	92 35 43	15	.20	.10	.50	200	1.5	300
57M2	37 33 33	92 33 5	10	.10	.10	>1.00	500	N	700
63W89	37 31 38	92 21 48	10	.20	.07	>1.00	300	N	<200
63W121	37 27 8	91 59 8	15	.15	.07	1.00	300	N	N
H13MO	36 58 57	93 20 45	15	.30	.20	1.00	200	N	N
H12	37 2 22	93 9 32	10	2.00	5.00	.50	1,000	N	N
64W94	36 59 40	92 14 19	20	3.00	3.00	.30	1,500	N	N

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s
17861	20	2,000	2.0	N	30	20	100	100	N
59M1	500	>5,000	10.0	N	10	300	70	100	N
11469	20	2,000	1.5	N	50	50	150	N	N
20186	70	>5,000	2.0	N	70	15	700	150	N
12328	30	3,000	1.5	N	50	30	100	150	N
GT1	2,000	1,000	10.0	N	100	150	200	150	N
GT5A	500	3,000	15.0	N	20	500	700	20	N
18139	2,000	2,000	20.0	N	50	500	5,000	500	N
63W25	200	>5,000	7.0	N	15	300	200	300	N
XT1	700	>5,000	10.0	N	20	300	150	200	N
21765	200	5,000	5.0	N	70	50	200	50	N
C09	200	>5,000	7.0	N	30	70	50	200	N
L05	700	>5,000	5.0	N	20	100	100	500	N
62W141	100	5,000	1.0	N	100	70	150	50	N
62W135	50	100	2.0	N	50	50	100	N	10
62W126	300	3,000	7.0	N	50	500	500	200	N
62W157	500	300	5.0	700	30	200	200	150	10
62W153	500	2,000	10.0	N	70	100	100	>1,000	N
62W145	150	100	N	N	5	20	20	50	15
63W72	1,000	>5,000	20.0	N	10	2,000	2,000	50	N
20465	200	1,000	1.5	N	70	500	500	30	10
62W134	300	1,500	10.0	N	50	500	500	100	20
NS1	20	500	2.0	N	70	1,000	1,000	500	7
62W159	30	100	1.0	20	20	70	70	20	20
62W149	300	500	10.0	N	100	1,000	1,000	N	N
TD1	1,000	150	10.0	N	30	200	200	1,000	N
62W161	500	20	10.0	N	200	700	700	100	5
NS2	1,000	50	7.0	N	50	5,000	5,000	70	N
UC2	500	30	15.0	N	50	100	100	1,000	10
63W5	700	300	7.0	N	20	50	50	500	N
63W29	1,000	300	10.0	N	100	200	200	300	5
63W82	500	70	10.0	N	50	1,000	1,000	200	20
63W113	1,000	3,000	10.0	100	20	5,000	5,000	30	100
61W48	200	3,000	5.0	N	70	100	100	150	10
NS3	150	200	10.0	N	50	1,500	1,500	50	N
NS4	200	200	7.0	N	50	100	100	150	N
NS5	300	100	7.0	N	200	70	70	500	N
UC1	500	100	5.0	N	70	100	100	100	70
NS6	300	70	2.0	N	70	20	500	70	5
57M2	1,000	50	15.0	N	N	300	150	>1,000	N
63W89	1,000	100	10.0	N	50	200	150	100	10
63W121	2,000	3,000	15.0	N	150	700	3,000	150	N
H13M0	1,000	200	5.0	N	30	100	70	150	N
H12	200	500	2.0	50	50	20	50	50	N
64W94	500	150	7.0	N	70	150	100	70	N

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
17861	N	100	100	N	700	20	150	5,000	1,000	N
59M1	20	30	30	15	3,000	150	1,500	N	>1,000	100
11469	N	150	70	N	200	30	70	1,000	1,000	N
20186	<20	150	150	N	700	15	300	200	>1,000	<100
12328	N	70	100	N	200	20	150	500	>1,000	<100
GT1	20	70	30	N	<100	30	2,000	N	>1,000	150
GT5A	20	100	50	20	100	30	>2,000	N	>1,000	200
18139	<20	70	50	15	500	30	2,000	N	>1,000	200
63W25	20	50	30	15	2,000	30	500	N	>1,000	150
XT1	30	50	70	10	1,500	50	1,500	N	>1,000	150
21765	20	100	50	10	N	70	700	N	>1,000	<100
C09	30	70	30	10	300	30	500	N	>1,000	N
L05	20	70	70	N	200	30	1,500	N	>1,000	100
62W141	N	150	100	N	100	10	150	N	>1,000	N
62W135	N	30	500	N	N	10	200	N	>1,000	N
62W126	20	150	150	N	N	15	1,500	N	>1,000	150
62W157	20	100	100	20	N	15	1,000	N	>1,000	100
62W153	20	100	100	N	N	20	>2,000	N	>1,000	700
62W145	N	20	2,000	15	100	10	100	N	>1,000	N
63W72	N	30	50	N	5,000	20	2,000	N	>1,000	200
20465	N	200	300	10	N	N	300	N	>1,000	N
62W134	N	100	200	N	N	20	2,000	N	>1,000	150
NS1	20	100	150	N	N	10	300	N	>1,000	200
62W159	N	70	200	70	N	N	150	N	>1,000	N
62W149	N	50	500	200	N	100	2,000	N	>1,000	500
TD1	30	50	70	15	N	20	2,000	N	>1,000	300
62W161	N	100	150	N	N	15	700	N	>1,000	150
NS2	50	100	50	N	N	15	1,000	N	>1,000	300
UC2	30	100	70	N	N	20	>2,000	N	>1,000	300
63W5	N	70	100	10	N	15	2,000	N	>1,000	150
63W29	30	100	100	10	N	15	1,000	N	>1,000	200
63W82	<20	50	150	10	N	50	700	N	>1,000	100
63W113	100	50	100	N	N	30	1,000	N	>1,000	100
61W48	N	50	100	N	N	N	200	N	>1,000	N
NS3	20	70	70	N	N	10	500	N	>1,000	100
NS4	50	50	100	N	N	10	700	N	>1,000	100
NS5	30	200	50	N	N	20	700	N	>1,000	200
UC1	N	100	300	N	N	15	500	N	>1,000	<100
NS6	20	100	70	N	N	20	500	N	>1,000	N
57M2	150	50	150	N	N	30	2,000	N	>1,000	1,000
63W89	<20	100	70	N	N	20	2,000	N	>1,000	200
63W121	20	70	70	N	N	20	2,000	N	>1,000	150
H13MO	N	70	100	N	N	15	700	N	>1,000	N
H12	N	30	50	N	N	N	200	N	>1,000	N
64W94	N	50	500	N	N	70	700	N	>1,000	N

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s
64W58	36 46 20	93 5 25	10	.50	.20	>1.00	200	N	N
64W49	36 49 0	92 55 0	15	1.00	2.00	.50	500	N	N
64W30	36 55 38	92 44 55	15	.07	.15	1.00	1,500	N	N
64W86	36 55 27	92 28 37	>20	.10	.07	.10	70	N	N
64W73	36 47 54	92 7 7	7	.70	.20	1.00	1,500	2.0	300
64W133	37 12 30	92 21 45	10	.70	1.50	>1.00	700	N	<200
65W32	37 10 7	92 3 27	15	.70	7.00	.50	2,000	N	N
W1	36 37 30	94 36 30	20	1.50	1.50	.70	700	3.0	N
66AK1	36 8 40	94 30 0	15	.30	.30	.50	100	N	<200
66AK2	36 17 38	94 27 55	20	.10	.10	>1.00	200	N	N
66AK3	36 29 15	94 27 38	20	.05	.05	1.00	100	N	N
66W84	36 31 15	94 17 45	20	.02	<.05	.50	50	N	<200
23821	36 35 20	93 50 30	15	.05	<.05	.30	500	N	500
67AK1	36 26 20	93 40 50	20	.02	.10	1.00	100	10.0	200
65W12	36 37 30	92 18 23	10	.50	2.00	.70	1,000	N	<200
H13AK	36 2 30	92 52 0	>20	.05	<.05	.20	70	5.0	200
H44AK	36 17 25	92 56 25	5	1.00	2.00	.30	200	1.5	N
H7	36 5 15	93 43 15	20	1.00	1.00	.30	500	2.0	N
58W49	38 6 10	91 8 5	7	5.00	10.00	.20	1,500	N	N
RC1	38 2 50	90 52 30	10	10.00	20.00	.07	>5,000	30.0	N
55W98	37 46 20	90 49 25	20	.50	1.00	.50	500	15.0	N
57M1	37 54 55	90 14 45	>20	.30	.20	.50	150	N	N
1HM	37 37 20	91 14 8	15	.30	.30	>1.00	1,500	N	N
424	37 38 40	91 4 12	10	5.00	10.00	.10	1,500	5.0	N
4MR	37 33 33	91 1 2	10	.05	.05	.10	100	3.0	N
131	37 27 15	90 53 35	7	.70	2.00	>1.00	2,000	7.0	2,000
MO8	37 31 23	90 1 5	15	.20	.07	.70	100	1.0	200
1RS	37 21 8	91 25 8	20	.10	.10	.50	1,000	5.0	300
LC12	37 21 45	91 7 45	20	.50	<.05	.50	200	30.0	<200
1RE	37 20 45	90 55 47	15	.70	.05	.70	70	N	500
1AN	37 17 38	90 44 53	15	1.50	3.00	.70	1,500	N	300
GA1	37 27 23	90 5 35	7	3.00	10.00	.30	3,000	N	200
SV1	37 10 15	91 34 25	15	.30	1.50	.50	300	3.0	<200
1EW	37 4 5	91 20 22	20	1.00	1.00	>1.00	2,000	N	N
231	37 11 5	91 8 5	15	.15	.10	>1.00	200	5.0	200
41	37 2 30	90 57 15	20	.07	.05	.30	100	3.0	300
DC1	37 1 30	90 31 15	20	2.00	5.00	>1.00	1,500	2.0	N
HF1	37 2 8	90 19 10	20	.10	.10	>1.00	200	N	N
65W23	36 52 46	91 43 13	10	1.00	5.00	>1.00	1,500	N	1,000
L4	36 52 12	91 39 0	20	.20	.20	1.00	300	5.0	500
SH1	36 46 38	91 33 30	10	.20	.10	>1.00	200	N	<200
BT1	36 46 20	91 26 0	7	>10.00	>20.00	.10	2,000	N	N
BT3	36 57 55	91 24 55	3	2.00	2.00	>1.00	3,000	N	300
164B	36 52 38	91 12 53	7	1.00	5.00	>1.00	700	N	N
STH2	36 47 57	91 7 35	5	2.00	10.00	.50	2,000	N	N

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s
64W58	200	500	10.0	N	20	200	500	70	N
64W49	150	1,000	2.0	N	15	10	50	30	N
64W30	300	70	5.0	N	15	70	700	70	N
64W86	N	70	N	N	7	N	50	N	N
64W73	300	100	5.0	N	15	200	300	100	10
64W133	500	200	10.0	N	20	100	2,000	200	N
65W32	200	150	5.0	N	70	150	300	300	N
W1	10	500	1.0	N	20	20	150	20	N
66AK1	15	100	2.0	N	10	30	70	20	N
66AK2	50	150	7.0	N	50	15	100	20	N
66AK3	20	100	7.0	N	50	50	70	N	N
66W84	10	50	2.0	N	10	10	50	N	N
23821	100	30	N	N	15	3,000	50	N	200
67AK1	70	100	2.0	N	30	50	50	20	N
65W12	300	700	3.0	N	20	200	70	100	10
H13AK	N	50	N	N	5	N	70	N	10
H44AK	30	30	2.0	N	15	N	100	20	7
H7	10	50	1.5	N	100	N	70	20	15
58W49	20	<20	1.0	N	20	N	20	N	N
RC1	10	20	N	N	100	N	2,000	N	20
55W98	200	50	1.5	N	50	100	500	200	N
57M1	150	50	1.5	N	15	N	150	N	N
1HM	1,500	70	10.0	N	50	200	3,000	N	150
424	20	<20	1.0	N	20	150	30	N	7
4MR	10	30	N	N	N	N	50	N	N
131	700	5,000	5.0	N	N	700	1,500	500	N
MO8	1,000	30	2.0	N	10	300	100	N	10
1RS	300	<20	5.0	N	15	100	200	100	20
LC12	500	500	2.0	N	300	30	20,000	N	50
1RE	150	70	10.0	N	10	300	5,000	100	N
1AN	200	30	1.5	<10	50	70	3,000	N	N
GA1	70	50	1.0	N	10	50	50	N	N
SV1	500	150	20.0	N	50	150	200	N	15
1EW	150	200	5.0	N	15	150	30	30	N
231	200	100	5.0	N	100	70	5,000	50	N
41	30	50	1.5	N	20	N	300	N	N
DC1	70	3,000	10.0	N	10	100	50	70	N
HF1	20	2,000	5.0	N	10	200	100	30	N
65W23	2,000	2,000	10.0	N	70	300	500	300	N
L4	1,000	700	10.0	N	20	200	200	200	15
SH1	2,000	500	20.0	N	30	500	10,000	300	N
BT1	50	700	1.0	N	20	150	100	70	15
BT3	7,000	700	20.0	N	N	1,000	100	700	N
164B	2,000	>5,000	10.0	N	20	300	1,500	200	N
STH2	700	1,000	5.0	N	15	200	150	50	20

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
64W58	N	30	30	N	N	10	1,500	N	>1,000	200
64W49	N	20	50	N	N	15	300	N	>1,000	N
64W30	N	70	100	N	N	N	1,000	N	>1,000	N
64W86	N	10	50	N	N	20	100	N	>1,000	N
64W73	N	70	150	N	N	20	700	N	>1,000	N
64W133	N	70	100	N	N	20	1,000	N	>1,000	N
65W32	N	100	300	N	N	30	700	N	>1,000	N
W1	N	50	150	N	N	10	150	N	>1,000	N
66AK1	N	30	100	N	N	15	200	N	>1,000	N
66AK2	20	100	100	10	N	20	1,000	N	>1,000	100
66AK3	20	70	100	20	N	20	700	N	>1,000	150
66W84	N	20	70	10	N	15	200	N	>1,000	N
23821	N	100	30	70	N	20	100	N	>1,000	N
67AK1	N	100	500	N	N	15	300	N	>1,000	N
65W12	N	100	150	N	500	15	700	N	>1,000	N
H13AK	N	15	20,000	N	N	N	100	N	>1,000	N
H44AK	N	10	5,000	N	N	15	100	N	>1,000	N
H7	N	70	1,000	<10	N	10	200	700	>1,000	N
58W49	N	10	500	N	N	15	70	N	>1,000	N
RC1	N	100	500	N	N	10	50	N	>1,000	N
55W98	N	70	300	20	N	10	500	N	>1,000	<100
57M1	N	30	70	N	N	10	500	N	>1,000	<100
1HM	N	200	150	N	N	70	2,000	N	>1,000	200
424	N	50	500	N	N	10	100	N	>1,000	N
4MR	N	20	500	N	N	N	100	N	>1,000	N
131	200	N	200	N	N	200	700	N	>1,000	N
MO8	N	30	70	N	N	20	500	N	>1,000	N
1RS	N	100	70	N	N	10	700	N	>1,000	<100
LC12	N	300	1,000	50	N	10	700	N	>1,000	N
1RE	N	70	300	N	N	20	300	N	>1,000	N
1AN	N	150	300	N	N	15	200	1,500	>1,000	N
GA1	N	10	50	10	N	30	100	N	>1,000	N
SV1	N	70	50	N	N	100	>2,000	N	>1,000	100
1EW	20	30	50	20	N	100	200	N	>1,000	N
231	50	30	150	15	N	30	700	N	>1,000	N
41	N	70	500	10	N	10	500	N	>1,000	N
DC1	N	20	500	20	N	100	700	N	>1,000	N
HF1	N	30	100	15	N	70	1,500	N	>1,000	N
65W23	N	70	150	N	1,500	50	1,000	N	>1,000	N
L4	20	50	200	20	500	50	2,000	N	>1,000	100
SH1	N	50	150	10	500	50	>2,000	N	>1,000	150
BT1	N	50	500	N	100	N	200	N	>1,000	N
BT3	100	50	200	N	300	70	1,500	N	>1,000	300
164B	N	70	100	N	1,000	20	2,000	N	>1,000	100
STH2	N	70	200	15	N	15	500	N	>1,000	<100

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s
CF1	36 44 30	91 5 30	7	2.00	15.00	.30	1,000	7.0	N
317A	36 45 15	91 4 35	5	5.00	20.00	.50	2,000	N	N
GV1	36 56 8	90 53 27	20	1.50	3.00	.70	3,000	30.0	700
31911A	36 40 30	90 47 5	10	3.00	10.00	.30	1,500	N	N
31910A	36 39 35	90 46 55	15	3.00	15.00	.20	1,000	N	N
3312A	36 47 20	90 33 40	20	2.00	5.00	1.00	1,500	N	N
WIL	36 59 47	94 51 13	20	.30	.20	.20	100	N	N
J3	37 1 33	95 0 21	20	2.00	2.00	>1.00	2,000	N	N
KB	37 0 30	94 51 30	20	.20	.10	.70	300	N	N
KX	37 0 17	94 50 11	15	.15	.05	1.00	300	N	N

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s
CF1	500	1,000	5.0	N	30	200	1,500	200	N
317A	700	2,000	2.0	N	10	150	150	100	10
GV1	300	3,000	3.0	N	30	300	150	50	30
31911A	300	3,000	1.5	N	10	100	100	150	50
31910A	500	3,000	2.0	N	70	200	100	50	50
3312A	>2,000	>5,000	3.0	N	7	100	10	30	N
WIL	100	>5,000	1.5	N	30	10	100	30	N
J3	200	200	10.0	N	20	20	70	200	N
KB	20	5,000	7.0	N	20	70	150	N	5
KX	50	300	2.0	N	5	30	100	N	N

TABLE 2. SPECTROGRAPHIC DATA FOR HEAVY-MINERAL CONCENTRATES OF BASAL SANDSTONES FROM MISSOURI, ARKANSAS AND KANSAS.--Continued

Sample	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sn-ppm s	Sr-ppm s	Y-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
CF1	N	70	2,000	50	1,000	15	500	N	>1,000	N
317A	N	20	100	N	200	15	300	N	>1,000	N
GV1	30	150	1,500	200	N	30	500	3,000	>1,000	N
31911A	N	30	150	20	>5,000	15	300	5,000	>1,000	N
31910A	N	100	200	N	1,000	15	200	500	>1,000	N
3312A	<20	15	70	50	N	100	300	N	>1,000	N
WIL	N	70	50	N	300	N	200	N	>1,000	N
J3	70	70	50	20	N	100	500	N	>1,000	N
KB	N	50	150	N	100	15	500	N	>1,000	N
KX	N	15	100	N	N	15	300	N	>1,000	N