STATE OF ARKANSAS

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Introduction and Background:
Mercury is found in small quantities in most rocks. Turekian and Wedepohl (1961) tabulated elemental abundances in the earth's crust and listed mercury values in sedimentary and igneous rocks as ranging from 30 ppb to 400 ppb. Fleischer (1970) reported that igneous and sedimentary rocks generally have less than 200 ppb mercury. Pierce, Botbol, and Learned (1970) tabulated statistics on selected rocks from Missouri and Kentucky, indicating mercury amounts in a range of 10 ppb to 1500 ppb. Regional studies of surficial materials by Shacklette, Boerngen, and Turner (1971) and Shacklette and Boerngen (1984) found typical mercury concentrations ranging from 10 to 3400 ppb in the eastern United States (east of 96th meridian) with a geometric mean value of about 96 ppb. Connor and Shacklette (1975) reported mercury concentrations in various sedimentary rocks from Missouri, Arkansas, Kansas, Oklahoma, and Kentucky as ranging from <10 ppb to 1500 ppb with geometric means from 8 ppb to 340 ppb.

Concern over elevated mercury concentrations in predator fish in parts of the Saline and Ouachita Rivers in 1992 led to an effort to establish the source of the mercury in these rivers. Public consideration focused on the possibility that the mercury was derived from human activities. Sediment and water samples taken throughout the Ouachita River basin did not indicate that the mercury was originating from a point source. The concentration of mercury in Ouachita River sediment was found to be relatively uniform, ranging from 20 ppb to 300 ppb with a mean of about 110 ppb (Armstrong, *et al*, 1994). In order to establish the background level of naturally occurring mercury in the rocks of the drainage basins of the Ouachita and Saline Rivers, a program of sampling and analysis was undertaken. 728 lithic samples were collected during the summer of 1994 from scattered sites throughout the drainage basins of these rivers, primarily in the Ouachita Mountain region of Arkansas (Figure 1) but including a few sites to the south and east of the mountain range.

Geology:
The Ouachita Mountains are an intricately folded, complexly thrust-faulted, and mildly to severely sheared mountain range composed of Paleozoic age sedimentary rocks. Late Paleozoic compressional forces formed the Ouachita Mountain fold belt. The exposed rocks are of Late Cambrian through Middle Pennsylvanian age. Most of the rocks are considered to be of deep-marine origin. The total combined thickness of the section is in excess of 40,000 feet (12,000+ meters). The rock types in decreasing order of abundance are shale, sandstone, siltstone, chert/novaculite, limestone, conglomerate, and tuff. Hydrothermal milky quartz veins of late Paleozoic age

commonly fill fractures in the rock and in places carry metallic mineralization (lead, zinc, copper, silver, antimony, mercury, etc. minerals) Along the eastern and southeastern margins of the Ouachita region, Late Cretaceous intrusions, mostly alkalic, were injected into the strata and created altered contact-metamorphosed aueroles. Also along the eastern and southern border of the mountains, Tertiary and Cretaceous sediments, respectively, overlap the Paleozoic strata.

A cinnabar (mercury sulfide) district is located in the southern part of the Ouachitas and is contained within the sampled area (Stroud, 1969; Clardy and Bush, 1976). The ore deposits of the district tend to be small and are usually associated with the major thrust faults in the area. All known occurrences of cinnabar were avoided when samples for this study were collected.

Procedures:

728 samples were collected from parts of seven counties occupying the Ouachita Mountain region of Arkansas (Figure 1). Four of the 728 samples were later discarded as unusable: one sample was taken from a mercury mine dump and the others were duplicates of other samples. The samples consisted of 2 to 5 kilograms of lithic material collected directly from both natural and man-made outcrops. Each outcrop was first cleaned by chipping away the surface rock: the sample was then taken from the fresh rock thus exposed. The samples were placed in cotton or plastic bags and labeled. The rock hammer was washed and wiped off after each sample was collected to prevent cross-sample contamination. Sample locations were indicated on USGS 7.5' series topographic maps and briefly described as to location, stratigraphic interval, and lithology. Some samples were single grab samples, others were composite or channel samples with material collected from several units of the exposed section. Samples were taken throughout the region at about 7 samples per township (6.7 samples per 36 square miles on average). The overall strategy was to collect random samples of the region without giving special consideration to the potential geochemical effects of stratigraphic interval, structure, mineralization, intrusions, metamorphic grade, depositional mode, etc. The resulting sample distribution seems to fairly represent the distribution of geologic strata and conditions of the region.

The chemical analyses were carried out at Ouachita Baptist University in Arkadelphia, AR. A sub sample of approximately 50 grams was removed from each sample bag and pulverized in an iron mortar. The mortar and pestle were thoroughly cleaned with de-ionized water, wiped with clean cheese cloth, and finally rinsed with reagent-grade acetone for each sample. That portion of the sample which passed through a 40-mesh sieve was collected and stored in a plastic or glass container. Throughout the procedure extreme caution was taken to prevent sample contamination.

Approximately 0.25 grams of the prepared rock samples were analyzed for mercury using EPA Method 245.5 (US EPA, 1991). This method consists of a strong acid (aqua regia) digestion in the presence of potassium permanganate. Potassium persulfate was also added to insure that oxidizing conditions were maintained during digestion. Following digestion, samples were diluted and the resulting solutions used for cold-vapor atomic absorption determination of mercury. Cold-vapor atomic absorption analysis of mercury was accomplished using a LDC Analytical@ mercury generator in conjunction with a LDC elemental mercury detector (Model 3200). The detection limits for this instrument are well below 5 nanograms of mercury.

The quality control program for this analysis consisted of periodic replication and spiking of samples. At least three reagent blanks and three sets of each standard were processed with each set of samples. External quality assurance was accomplished by analyzing a commercially available sediment reference standard. Results from the analysis of the reference sediment sample was within 3% of the reported value. The purpose of the EPA procedure is to evaluate mercury in sediment which is likely to be involved in the processes occurring in the aquatic environment. This procedure does not dissolve the silicate phase. Although it is likely that a high percentage of mercury was leached and dissolved during the strong acid digestion, the results should be qualified in that the reported numbers represent a lower limit for the mercury concentration in the rocks. The fact that a good agreement was obtained with the sediment reference sample suggests that this procedure does extract most of the mercury in the sample.

The analytical method used has a somewhat logarithmic response and results in numbers which generally have only two significant figures when values are 10 ppb and above. In the range of 1 to 9 ppb there is only one significant figure and a second digit is not reported. Between 10 and 99 ppb both digits are significant and are reported. For concentrations above 99 ppb only the first two digits are significant even though more digits may be reported.

Results:

The sample mercury concentrations follow a typical strong positively skewed frequency distribution common to many trace elements in natural materials (Figure 3). With this type of logarithmic distribution the geometric mean is usually a better estimator of central tendency than the arithmetic mean. The geometric mean is the antilogarithm of the mean of the logarithms of the sample concentrations. Just as important as the mean is the amount of scatter around that mean. In logarithmic distributions (Figure 4) the measure of scatter is the geometric deviation. The geometric deviation is the antilogarithm of the standard deviation of the logarithms of the sample content. Where M represents the geometric mean and D represents the geometric deviation, approximately 68% of a random sample from the same population should fall between M/D and M*D, about 95% of a random sample should fall between M/D^2 and $M*D^2$, and 99.7% of the sample should be between M/D^3 and $M*D^3$.

The geometric mean of all the samples used in this study is 88 ppb with a geometric deviation of 2.841. The sample mercury concentrations ranged from a low of 3 ppb (from a Johns Valley sandstone sample, #492) to a high of 6100 ppb (from a Bigfork black chert sample, #621). The median concentration value of the samples is 78 ppb.

Only 13 samples had mercury quantities greater than 1000 ppb. All of the mercury analysis data are summarized in Table 1 and fully tabulated in Table 2.

The mercury sample concentration data were also grouped by formal stratigraphic unit, geologic time period, principle lithology, and organic or carbon indicators. In general, the different breakdowns of the concentration data do not clearly show any one group to be distinctly separate from any another group to a high level of significance. However a few modest trends and differences seem to be suggested. The breakdown by stratigraphic formation hints that the Ordovician through lower Mississippian strata contain generally higher levels of mercury than the Pennsylvanian age sediments (Table 1). The observation that the Ordovician through lower Mississippian sediments were, in general, deposited more slowly than the Pennsylvanian sediments (Stone and McFarland, 1981) might suggest that the influx of mercury over a given interval of time was relatively constant. If so, then during the Pennsylvanian a constant background "rain" of mercury would be diluted by the greater rate of sediment accumulation resulting in the lower average quantity observed.

A few igneous rocks were sampled during the course of this survey. Most of these were sills and dikes of Cretaceous age. There was no significant difference in the amount of mercury between the Cretaceous igneous rock and the Cretaceous sedimentary rock samples.

It has been suggested that rocks containing organic component indicators might have higher than normal concentrations of minor elements including mercury (Vine, Tourtelot, and Keith, 1969). Even though the geometric means of the two breakdowns (Table 1, Miscellaneous) based on these indicators are high relative to the other means, the observed range and geometric deviation suggests that the difference is not very significant.

The geographic distribution of the sample concentrations is displayed in Figure 2. A few areas and patterns of generally higher mercury concentrations can be noted, but they may not be indicative of any significant underlying controls. There is an area of generally higher mercury concentration in southwestern Montgomery County. The area is underlain by rocks of Ordovician through lower Mississippian age and is known for other economic minerals (Master, 1986, Master and Stone, 1986). Another region of higher mercury sample concentrations seems to be located along the Garland/Saline County line; however this latter area is not otherwise remarkable.

A vague grid-like pattern of relatively high mercury sample concentrations trending northeast-southwest in the eastern part of the sampled region and northwest-southeast in the western part of the sampled region seems to exist. These indefinite (and possibility nonexistent) trends may be reflective of the underlying structural fabric of the Ouachitas. Some other nebulous patterns have been suggested by different methods of displaying the current concentration data but none of them are accepted as being reflective of any true underlying controls at this time. The various patterns that are suggested seem to be just the natural range of variations found in most trace elements.

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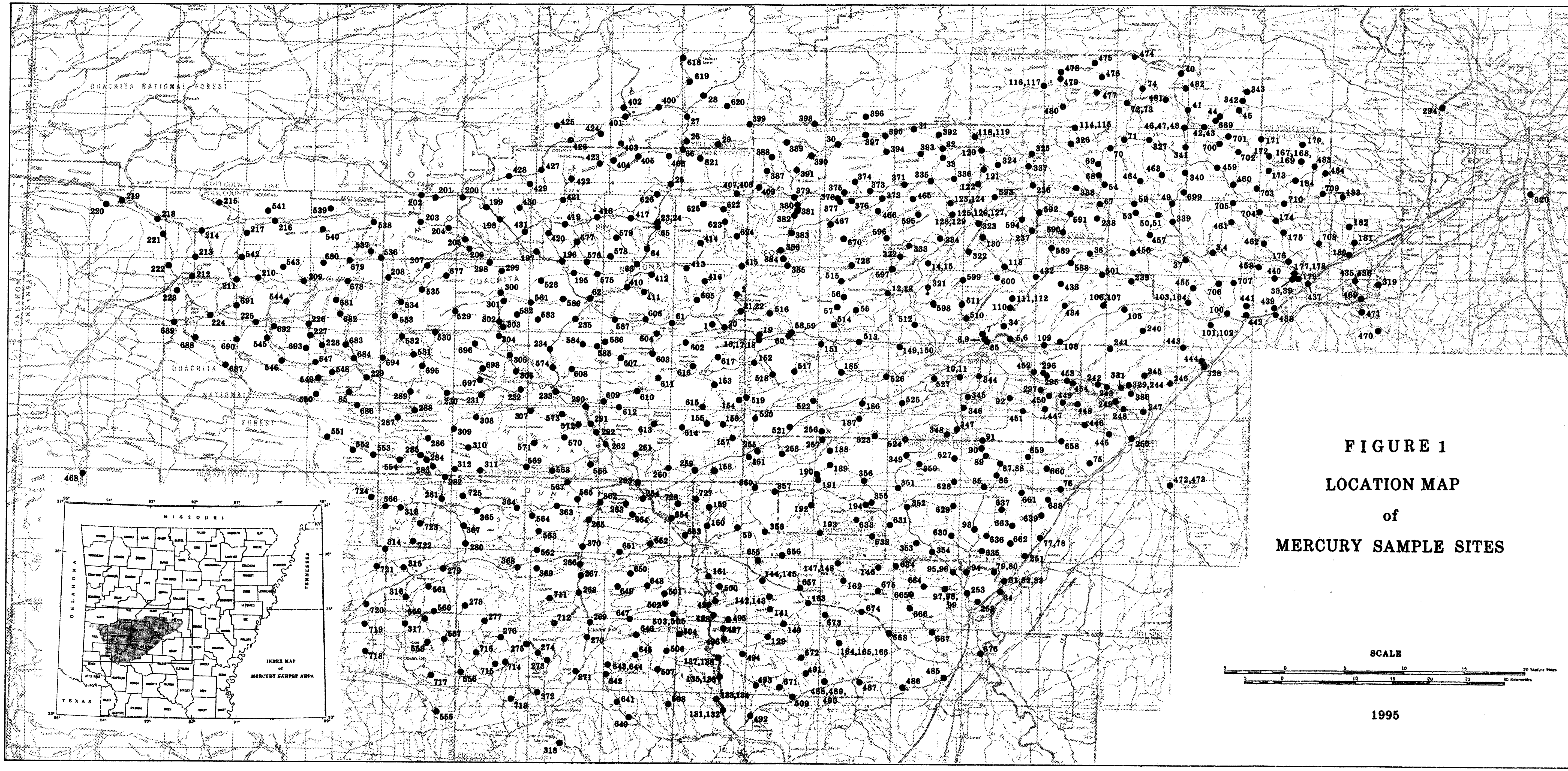

FIGURE 1

LOCATION MAP
of
MERCURY SAMPLE SITES

SCALE

1995

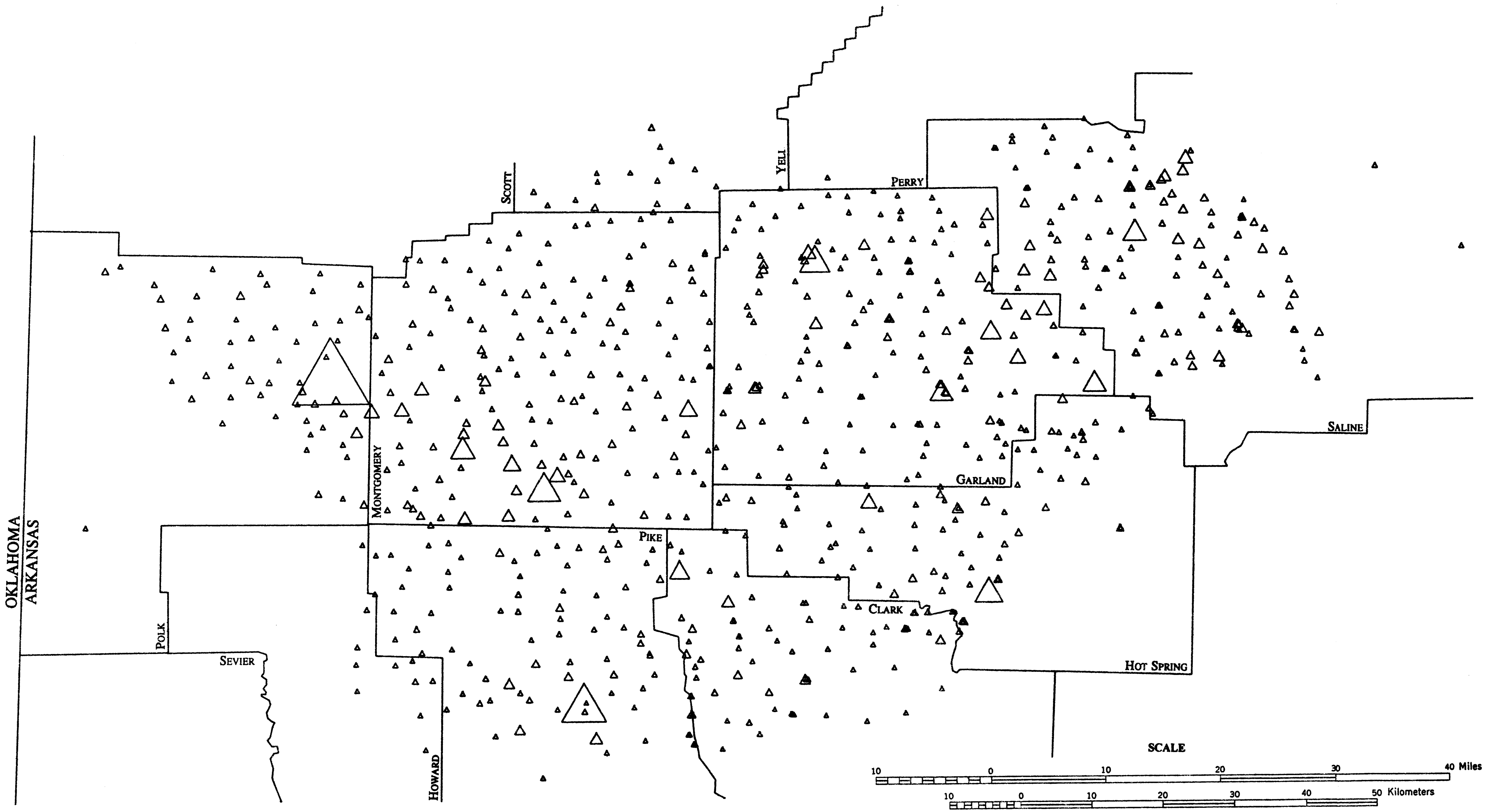

FIGURE 2. The distribution of mercury concentrations in the bedrock of the Ouachita Mountains of Arkansas. The size of the triangle represents the relative magnitude of the sample concentration displayed by way of a linear scale.

FIGURE 3
Distribution of Mercury Sample Concentrations

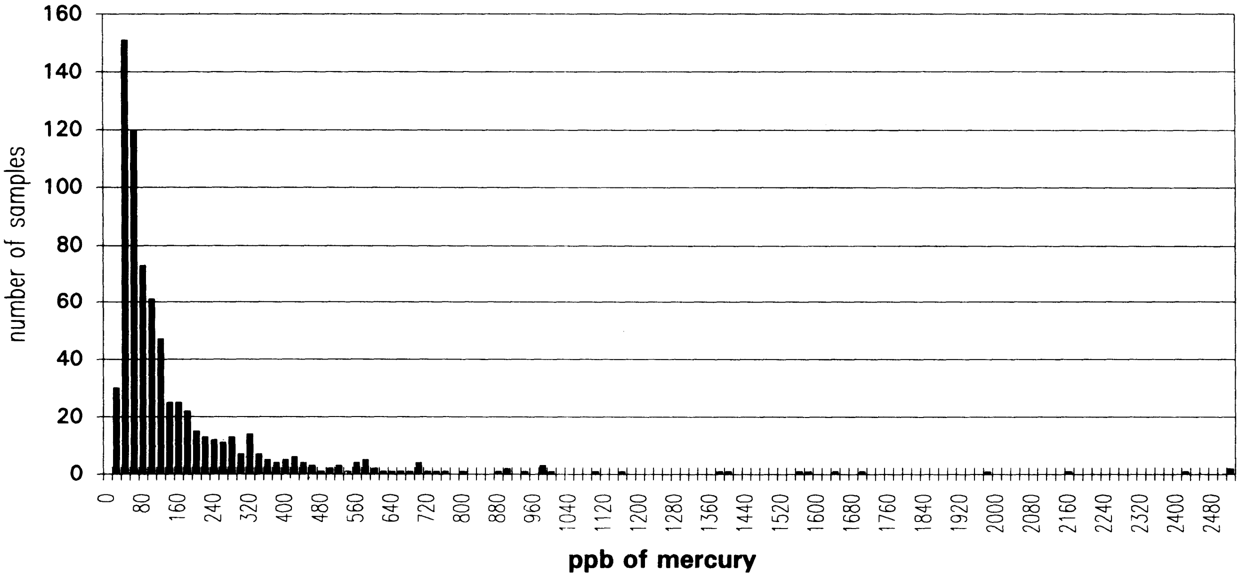

FIGURE 4
Log Distribution of Mercury Sample Concentrations

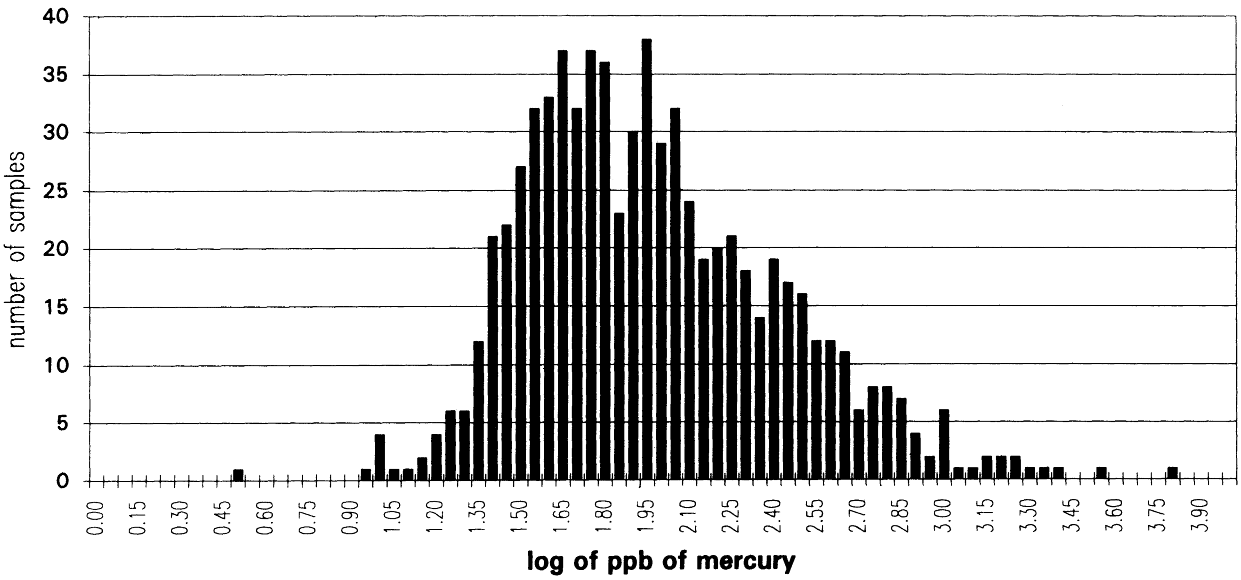

Table 1

Ouachita Mountain Mercury Statistics

The mean (M) is a geometric mean; the deviation (D) is a geometric deviation.
Means and ranges are reported in parts per billion (ppb).

All Samples					Percent of random samples likely to be within listed range					
		M	D	Observed	~68%		~95%		~99.7%	
	# of Samples	Mean	Deviation	Range	M/D	MD	M/DD	MDD	M/DDD	MDDD
All samples	724	88	2.841	3 - 6100	31	250	11	710	4	2018

By Formation*					Percent of random samples likely to be within listed range					
		M	D	Observed	~68%		~95%		~99.7%	
	# of Samples	Mean	Deviation	Range	M/D	MD	M/DD	MDD	M/DDD	MDDD
Atoka	19	61	2.338	10 - 228	26	143	11	333	5	780
Johns Valley	24	40	2.198	3 - 164	18	88	8	193	4	425
Jackfork	86	65	2.790	9 - 3397	23	181	8	506	3	1412
Stanley	228	67	2.204	16 - 1970	30	148	14	325	6	717
Arkansas Novaculite	40	127	2.977	23 - 1547	43	378	14	1126	5	3351
Polk Creek	16	187	2.388	39 - 1570	78	447	33	1066	14	2547
Bigfork	39	210	3.025	28 - 6100	69	635	23	1922	8	5813
Womble	46	193	3.426	24 - 2413	56	661	16	2265	5	7761
Blakely	24	132	2.030	34 - 686	65	268	32	544	16	1104
Mazarn	70	104	2.362	20 - 584	44	246	19	580	8	1370
Crystal Mountain	14	70	2.048	24 - 328	34	143	17	294	8	601
Collier	12	102	2.399	35 - 576	43	245	18	587	7	1408

* Formations listed only when more than 10 samples were analyzed

By Period	# of Samples	M Mean	D Deviation	Observed Range	Percent of random samples likely to be within listed range					
					~68%		~95%		~99.7%	
					M/D	MD	M/DD	MDD	M/ DDD	MDDD
Tertiary	8	121	2.483	19 - 333	49	300	20	746	8	1852
Cretaceous **	20	52	3.424	11 - 690	15	178	4	610	1	2087
Pennsylvanian	134	60	2.664	3 - 3397	23	160	8	426	3	1134
Mississippian/Devonian	276	76	2.448	16 - 1970	31	186	13	455	5	1115
Silurian	14	47	2.292	8 - 222	21	108	9	247	4	566
Ordovician/Cambrian	243	146	2.803	20 - 6100	52	409	19	1147	7	3215

** only sedimentary rock samples used

By Principle Lithology	# of Samples	M Mean	D Deviation	Observed Range	Percent of random samples likely to be within listed range					
					~68%		~95%		~99.7%	
					M/D	MD	M/DD	MDD	M/DDD	MDDD
Igneous (Cretaceous)	21	57	3.011	9 - 439	19	172	6	517	2	1556
Limestone	24	113	3.161	19 - 1697	36	357	11	1129	4	3569
Chert	66	189	2.724	28 - 6100	69	515	25	1402	9	3820
Shale	514	86	2.705	8 - 3397	32	233	12	629	4	1702
Siltstone	17	110	2.695	34 - 2413	41	296	15	799	6	2153
Sandstone	37	47	2.657	3 - 420	18	125	7	332	3	882

Miscellaneous	# of Samples	M Mean	D Deviation	Observed Range	Percent of random samples likely to be within listed range					
					~68%		~95%		~99.7%	
					M/D	MD	M/DD	MDD	M/DDD	MDDD
Organic indicators***	19	294	3.811	37 - 6100	77	1120	20	4270	5	16273
Black/carbon****	14	371	3.836	57 - 6100	97	1423	25	5459	7	20942

*** black color, pyrite, carbon, lignite, asphaltite, or fossils
**** black color, carbon, lignite, or asphaltite

Table 2

Tabulation of Ouachita Mountain rock samples listing mercury concentration, stratigraphic unit, and lithology

Sample locations shown in Figure 1. Mercury concentration expressed in parts per billion (ppb). Stratigraphic notation is as follows: O€c=Collier, Ocm=Crystal Mt., Om=Mazarn, Oby=Blakely, Ow=Womble, Obf=Bigfork, Opc=Polk Creek, Sbl=Blaylock, Smm=Missouri Mt., MDa=Arkansas Novaculite, Ms=Stanley, ℙj=Jackfork, ℙjv=Johns Valley, ℙa=Atoka, Kt=Trinity, Kto=Tokio, Kb=Brownstown, Ks=Saratoga, Kn=Nacatoch Ki=igneous, Tm=Midway, Tw=Wilcox, Qt=terrace. Lithology expressed in order of abundance/importance.

Sample	Hg (ppb)	Formation	Part	Lithology
1	66	O€c		limestone
2	123	O€c		limestone
3	87	Om		limestone, shale
4	141	Ki	dike	lamprophyre
5	69	Ms	lower	shale
6	150	Ms	lower	sandstone, siltstone
7	304	Obf	upper	chert
8	1547	MDa	middle	shale, chert
9	312	MDa	lower	novaculite, conglomerate
10	53	Ms	middle	shale, siltstone
11	142	Ms	middle	sandstone, quartz veinlets
12	156	Oby		shale
13	76	Oby		sandstone, siltstone
14	42	Ow		limestone, conglomerate
15	416	Ow		shale, siltstone
16	163	Oby		shale
17	73	Oby		sandstone
18	43	Ki	dike	lamprophyre
19	63	Om	upper	shale
20	39	O€c		limestone, shale
21	34	Ocm		shale
22	41	Ocm		sandstone, quartz veinlets
23	82	Smm/MDa		shale, chert
24	60	MDa/Ms		novaculite, shale
25	51	Ms	middle	sandstone, siltstone, shale
26	113	Ms	upper	chert, shale
27	76	ℙj	upper	shale, sandstone
28	43	ℙjv		shale, sandstone, siltstone
29	33	Ms	upper	shale, siltstone, sandstone
30	62	Ms	upper	shale, sandstone
31	27	Ms	upper	shale, siltstone
32	73	ℙj	lower	shale, sandstone
33	43	Ms	lower	shale
34	39	Opc		shale
35	236	Q		tufa, (hot springs)
36	938	Obf		chert, shale
37	80	Om		siltstone, shale
38	69	Ki		igneous breccia
39	79	Om		siltstone, shale

Sample	Hg (ppb)	Formation	Part	Lithology
40	84	ℙj		shale, sandstone
41	28	Ms		shale,
42	53	Ms	lower	shale, pyrite
43	439	Ki	dike	lamprophyre
44	719	Ms/ℙj		shale
45	574	Ow		shale
46	565	Obf		chert
47	86	Ow		limestone
48	275	Om	upper	shale
49	114	Om		siltstone, shale
50	117	Ms	lower	shale
51	69	Ow		limestone
52	117	Obf		chert
53	106	Oby		limestone, shale, conglomerate
54	199	Obf		chert, siltstone
55	99	Obf		chert, siltstone
56	88	Om		shale, siltstone
57	87	Ocm	upper	sandstone
58	377	Ow		shale
59	152	Ow		limestone
60	666	Ow		shale
61	77	Ow		shale, limestone
62	85	Ow		shale, limestone
63	289	Om/Oby		shale
64	236	MDa		shale, chert
65	267	Obf		chert, shale
66	80	Ms	upper	shale, siltstone
67	186	MDa		sandstone, shale, chert, conglomerate
68	39	Smm		shale, siltstone
69	114	Ow		limestone, shale
70	123	Ms	lower	shale
71	81	Om		shale, siltstone
72	47	Ms	upper	shale, chert
73	34	Ms	upper	sandstone
74	78	ℙj	lower	shale, siltstone
75	215	Ms	lower/middle	shale, siltstone
76	249	Ms	middle	shale, siltstone
77	72	ℙj	lower	sandstone, siltstone
78	309	ℙj	lower	shale
79	35	ℙj	lower	sandstone
80	47	ℙj	lower	shale, siltstone
81	133	ℙj	upper	sandstone
82	144	ℙj	upper	shale, siltstone
83	272	ℙj	upper	sandstone, quartz veinlets, fault zone
84	164	ℙjv		shale, siltstone
85	77	Ms	middle	shale, siltstone
86	44	Ms	lower	shale, siltstone
87	542	MDa	middle	chert, shale, novaculite
88	58	MDa	lower	novaculite
89	25	MDa	lower	shale
90	267	MDa	middle	chert, shale, novaculite
91	66	Ms	lower	shale, chert, siltstone
92	54	Ms	middle	shale, sandstone

Sample	Hg (ppb)	Formation	Part	Lithology
93	185	Ms	middle	shale, siltstone
94	145	Ms/ℙj		shale, siltstone
95	124	Ms	upper	shale, siltstone, sandstone
96	148	ℙj	lower	shale, siltstone, sandstone
97	196	ℙj	upper	siltstone, sandstone
98	95	ℙj	upper	shale, siltstone
99	81	ℙj	upper	sandstone
100	162	Om		shale, siltstone
101	66	Ow		shale
102	94	Ow		siltstone, sandstone
103	231	Om		shale
104	236	Ki	dike	lamprophyre
105	58	Obf		chert, siltstone
106	43	MDa	lower	novaculite
107	9	Ki	dike	lamprophyre
108	31	Ms	lower	tuff, sandstone
109	29	Ms	lower	shale
110	315	Opc		shale
111	175	Obf		chert, siltstone, (iron oxides)
112	231	Opc		shale
113	112	Oby		shale, sandstone
114	66	ℙj		shale
115	41	ℙj		sandstone
116	40	Ms	lower	shale
117	18	Ms	lower	sandstone
118	52	ℙj	lower	shale
119	29	ℙj	lower	sandstone, quartz veinlets
120	21	Ms	lower	shale, siltstone
121	59	Om		shale
122	47	OЄc		shale, siltstone
123	194	Ocm/Om		shale
124	39	Ocm		sandstone, conglomerate
125	100	OЄc	upper	shale, siltstone
126	92	Ocm		conglomerate, sandstone
127	125	Ocm		granitic meta-arkose erratic
128	117	Om	lower	limestone, shale
129	87	Om		chert, shale
130	135	Oby	upper	shale, sandstone
131	59	ℙa	lower	shale, siltstone
132	35	ℙa	lower	sandstone
133	34	ℙa	lower	shale, siltstone
134	15	ℙa	lower	sandstone
135	355	ℙj		shale
136	57	ℙj		sandstone
137	63	ℙa	lower	shale, siltstone
138	106	ℙa	lower	sandstone
139	391	ℙj		shale, sandstone
140	29	ℙa	lower	shale, siltstone
141	83	ℙjv		shale, sandstone
142	51	Ms/ℙj		shale
143	14	Ms/ℙj		sandstone
144	113	Ms	upper	shale
145	22	Ms	upper	sandstone

Sample	Hg (ppb)	Formation	Part	Lithology
146	29	Ms		sandstone
147	33	Ms		shale
148	35	Ms		sandstone
149	63	Ms	lower	shale
150	27	Ms	lower	sandstone
151	94	Ms	lower	shale, siltstone
152	117	Ow	upper	limestone, shale
153	240	MDa	lower/middle	chert, novaculite, shale
154	32	Ms		shale, sandstone
155	42	Ms	upper	shale, sandstone
156	12	ℙj	lower	shale, sandstone
157	30	Ms	lower	shale, sandstone
158	63	Ms	middle	shale, sandstone
159	28	Ms	lower	shale, sandstone
160	1381	MDa/Ms		shale, chert
161	149	Ms	middle	shale, sandstone
162	163	ℙj	lower	shale, sandstone
163	29	ℙjv		shale, sandstone
164	515	ℙj	upper	shale
165	121	ℙj	upper	sandstone, siltstone
166	31	ℙjv		shale, sandstone
167	30	p€i		serpentine
168	95	Om		shale
169	317	Obf		chert, shale
170	24	Ocm		shale, chert, granitic meta-arkose
171	285	Ocm/Om		shale, chert
172	165	Om		shale, siltstone
173	81	Om		shale, siltstone
174	366	Om		shale
175	41	Om		shale, limestone
176	47	Om		shale, limestone
177	421	Om		shale, siltstone
178	256	Ki	dike	phonolite-trachyte
179	432	Ki	dike	lamprophyre
180	253	Om		shale
181	266	Om		shale, siltstone
182	175	Om		shale
183	262	Ow	upper	shale, chert
184	207	Om		shale
185	97	Ms	middle	shale, sandstone
186	28	Ms	middle	shale, sandstone
187	117	Ms	middle	shale, sandstone
188	53	Ms	middle	shale, sandstone
189	38	MDa		novaculite, chert
190	41	MDa		novaculite
191	79	Ms	lower	shale, siltstone
192	121	Ms	lower	shale, sandstone
193	90	Ms	lower	shale, sandstone
194	56	Ms	lower	shale, sandstone
195	141	Obf		chert, siltstone, wavellite
196	80	MDa		shale, conglomerate, chert
197	69	Ms	lower	shale, siltstone, sandstone
198	123	Ms	middle	shale

Sample	Hg (ppb)	Formation	Part	Lithology
199	34	Ms	upper	shale, sandstone
200	66	ℙj	middle	shale, sandstone
201	57	ℙj	upper	shale
202	86	ℙj	upper	shale, sandstone, quartz veinlets
203	152	ℙj	middle	shale, sandstone
204	231	ℙj	lower	shale, sandstone
205	16	Ms	upper	shale, sandstone
206	53	Ms	upper	shale, sandstone
207	207	Ms	middle	chert, shale, sandstone
208	53	Ms	middle	shale
209	68	Ms	middle	shale
210	103	Ms	middle	shale, siltstone
211	24	Ms	middle	shale, sandstone
212	49	Ms	middle	shale, sandstone
213	90	Ms	middle	chert, shale, sandstone
214	109	Ms	middle	shale, cone-in-cone concretion
215	58	Ms	upper	shale, sandstone
216	111	Ms	middle	shale
217	332	Ms	middle/upper	chert, shale
218	111	Ms	middle	shale, sandstone
219	51	Ms	middle	shale
220	224	ℙj	lower	shale, sandstone
221	212	ℙj	lower	shale, sandstone
222	183	Ms	upper	shale, sandstone
223	42	Ms	middle	shale, sandstone
224	168	Ms	lower	shale, siltstone
225	278	Ms	lower	shale, siltstone
226	51	MDa		shale, chert
227	214	Obf		chert, shale
228	232	Opc		shale
229	613	Ow		limestone, shale
230	180	Opc		shale, chert
231	1697	Ow		limestone, shale
232	474	Ow		limestone, shale
233	160	Oby		shale, siltstone
234	133	Ocm		shale, sandstone
235	35	O€c		limestone, chert
236	40	O€c		conglomerate, limestone, shale
237	458	Om/Oby		shale, siltstone, sandstone
238	652	Ow		shale, siltstone
239	94	Ow		limestone, siltstone, shale
240	1570	Opc		shale
241	439	Ms	lower	shale, siltstone
242	199	Ms	lower	shale, siltstone, contact metamorphism
243	23	Ki	pluton	carbonatite
244	157	MDa	lower	novaculite, vanadium, titanium ore
245	95	Ms	lower	shale, barite
246	24	MDa	lower	novaculite
247	36	MDa	lower	novaculite
248	79	Ms	lower	shale, sandstone
249	33	Ki	pluton	nepheline syenite
250	225	Tm	lower	limestone, fossils
251	1970	Ms	upper	shale, sandstone

Sample	Hg (ppb)	Formation	Part	Lithology
252	420	Kb		sand, marl
253	37	ℙjv		shale, sandstone
254	186	Ms	lower	shale, sandstone
255	210	Ms	middle	shale, sandstone
256	145	Ms	upper	shale, chert
257	29	ℙj	lower	shale, sandstone
258	186	Ms	middle/upper	shale, chert, sandstone
259	48	Ms	lower	shale, sandstone
260	275	Ms	lower	barite, shale, chert
261	77	Ms	lower	shale, siltstone, sandstone
262	420	MDa	middle	chert, shale
263	208	MDa/Ms		chert, shale
264	92	Ms	middle	shale, sandstone
265	55	ℙj	lower	shale, sandstone
266	306	Ms	middle	shale, sandstone
267	88	ℙj	lower	shale, sandstone
268	79	ℙjv	lower	shale, sandstone
269	87	ℙj	lower	shale, sandstone
270	360	ℙjv/ℙa		shale, sandstone
271	48	Kt	lower	gravel, sand, clay
272	508	ℙj	upper	shale, siltstone, sandstone, carbon
273	151	ℙa	lower	shale, sandstone
274	65	ℙjv		shale, siltstone, sandstone
275	547	ℙj	upper	shale, siltstone, sandstone, quartz veinlets
276	104	Ms	upper	shale
277	23	ℙj		shale, sandstone
278	55	ℙj	lower	shale, sandstone
279	57	Ms	upper/middle	shale, siltstone
280	34	ℙj		shale, sandstone
281	36	Ms	lower	shale, sandstone
282	131	MDa	middle/lower	shale, chert, fault gouge
283	307	Obf/Opc		chert, shale
284	222	Sbl		shale, sandstone
285	328	MDa	middle/lower	shale, chert, novaculite
286	56	Ms	lower	shale
287	105	Smm		shale, chert
288	61	Ms	lower	shale, siltstone
289	159	Obf		shale, chert
290	161	Oby		shale, sandstone
291	216	Ow	lower	shale, siltstone
292	63	Ow	upper	chert, shale, siltstone
293	388	Ms	lower	shale, sandstone
294	42	ℙj	middle	shale, siltstone
295	59	Ki		vanadium ore, contact metamorphism
296	28	Ki		miserite/wollastonite, contact metamorphism
297	88	Ki		flourite, quartz vein
298	80	Ms	middle	shale, siltstone
299	202	MDa		shale, chert
300	305	Obf		chert, shale
301	88	Om/Oby		shale, siltstone
302	88	Om	lower	shale, siltstone
303	576	OЄc	upper	shale, limestone, chert
304	88	Om	lower	shale, limestone

Sample	Hg (ppb)	Formation	Part	Lithology
305	38	Om	upper	shale, siltstone
306	555	Ow/Obf		shale, chert
307	1088	Ow	upper	shale, siltstone
308	111	Obf		chert
309	193	MDa	middle	chert, novaculite, shale
310	85	Ms	lower	shale, siltstone
311	757	MDa/Ms		novaculite, shale, barite
312	165	Obf		chert, shale
313	35	Ms	middle	sandstone, shale
314	24	ℙj	lower	shale, sandstone
315	47	Ms	upper	shale, sandstone
316	30	Ms	upper	shale, sandstone
317	64	ℙj	lower	shale, sandstone
318	25	Ki	pipe	kimberlite breccia
319	333	Tw		bauxite
320	41	Ki	pluton	nepheline syenite
321	269	Obf		chert, shale
322	93	Obf		chert, shale
323	34	Oby		shale, sandstone
324	102	O€c/Ocm		shale, sandstone
325	694	Ocm/Om		shale, siltstone
326	392	Obf		chert, shale
327	157	Om		shale
328	57	MDa	middle/lower	chert, conglomerate, shale
329	28	Ki	dike	phonolite
330	157	Ki		smoky quartz, brookite, red clay, contact metamorphism
331	20	Ki	pluton	ijolite
332	163	Oby	upper	shale, sandstone
333	52	Obf		chert, siltstone, shale
334	40	Om/Oby		shale, sandstone
335	109	Om	upper	shale
336	85	Obf		chert, shale
337	125	O€c		shale, siliceous concretions
338	491	Ow		shale, siltstone
339	134	Ocm	upper	siltstone, shale
340	1632	Ow/Obf		shale, chert
341	36	Om		shale
342	874	Opc/MDa		shale, chert
343	64	ℙj	lower	shale, sandstone
344	59	Ms	middle	shale, sandstone
345	32	Ms	middle	shale, sandstone
346	82	Ms	middle	shale, sandstone
347	37	Ms	lower	shale, siltstone, pyrite
348	36	MDa	middle	shale, chert
349	968	MDa	middle	shale, chert, black
350	58	Sbl		siltstone, shale
351	37	Ms	lower	shale, sandstone
352	33	Ms	middle	shale, sandstone
353	36	Ms	middle	shale, sandstone
354	320	Ms	middle	shale, sandstone
355	37	Ms	lower	shale, siltstone
356	37	Ms	lower	shale, sandstone
357	51	MDa	upper	chert, shale

Sample	Hg (ppb)	Formation	Part	Lithology
358	49	Ms	middle	shale, sandstone
359	40	Ms	lower	shale, siltstone
360	41	MDa/Ms		shale, chert
361	48	Ms	middle	shale, siltstone
362	107	MDa/Ms		shale, chert
363	87	Ms	lower	shale, sandstone
364	334	Ms	lower	chert, shale
365	28	Ms	lower	shale, sandstone
366	30	Ms	lower	shale, sandstone
367	28	Ms	upper	shale, sandstone
368	37	Ms	middle	shale, siltstone, sandstone
369	72	Ms	middle	shale, siltstone, sandstone
370	26	Ms	middle	shale, sandstone
371	582	Om		shale
372	69	Om		siltstone, shale
373	20	Om	upper	limestone, shale
374	44	Ms	middle	shale, siltstone
375	967	Obf		chert, shale
376	2159	Ow	upper	shale, chert
377	299	Opc		shale
378	108	MDa	middle	chert, shale, siltstone
379	79	Ms	lower	shale
380	415	MDa		shale, chert
381	400	Opc		shale
382	184	Obf		chert, shale
383	130	Om		shale, limestone
384	64	O€c/Ocm		shale, limestone
385	93	Om		shale, siltstone, limestone
386	97	Qt		clay, sand, gravel
387	43	Ms	middle	shale, sandstone
388	39	ℙj	middle	shale, sandstone
389	63	Ms	middle	shale, siltstone
390	23	Ms	middle	shale, sandstone
391	25	Ms	middle	shale, siltstone, sandstone
392	25	ℙj	lower/middle	shale, sandstone
393	25	ℙj	lower	shale, sandstone
394	30	ℙj	lower	shale, sandstone
395	32	ℙj	middle	shale, sandstone
396	29	ℙj	middle	shale
397	37	Ms	middle/upper	shale, sandstone
398	15	ℙj	middle	shale, sandstone
399	46	ℙj	lower/middle	shale, sandstone
400	34	ℙjv		shale, siltstone
401	16	ℙjv		shale, siltstone
402	22	ℙj/ℙjv		shale, sandstone
403	242	Ms	upper	shale, chert
404	15	ℙj	middle	shale, sandstone
405	47	Ms	middle	shale, siltstone, iron concretion
406	37	Ms	middle	shale, siltstone
407	no data			
408	42	Ms	lower	shale, siltstone
409	53	Ms	lower	siltstone, shale
410	24	Ow		shale, sandstone

Sample	Hg (ppb)	Formation	Part	Lithology
411	30	Ow		shale
412	88	Ow		shale
413	65	Om		shale
414	158	Om		shale
415	107	Ow		shale, siltstone, chert
416	40	Ow		siltstone, shale
417	37	Ms	lower	shale
418	59	Ms	lower	shale
419	63	Ms	lower	shale
420	317	Ms	lower	shale, chert
421	31	Ms	middle	shale, sandstone
422	52	ℙj	middle	shale
423	37	ℙj	middle	shale, sandstone
424	34	ℙjv		siltstone, shale
425	110	ℙa	lower	chert, shale, sandstone
426	55	ℙj/ℙjv		shale
427	33	ℙj	upper	shale, sandstone
428	44	ℙjv	lower	shale, siltstone
429	27	ℙj	upper	shale, sandstone
430	36	Ms	middle	shale, sandstone
431	82	Ms	lower	shale
432	1363	Obf		chert
433	176	Opc		shale
434	979	MDa	middle	shale, black
435	126	Tm	upper	clay/shale
436	162	Tw		lignitic sand
437	101	Qt		clay, sand, gravel
438	19	Tm	lower	limestone, conglomerate
439	568	Om		shale, siltstone, pyrite concretion
440	45	Om		shale, siltstone
441	349	Om		siltstone, shale
442	358	K/T		clay, conglomerate, novaculite
443	21	Sbl		shale, sandstone
444	117	Ow	upper	shale, siltstone, sandstone
445	102	Sbl		sandstone, shale
446	42	Ms	lower	shale, sandstone
447	49	Ms	lower	shale, siltstone
448	32	Ms	lower	shale, sandstone
449	38	Ki	dike	lamprophyre, biotite, xenolith-bearing
450	56	Ms	lower	shale, sandstone
451	59	Ms	lower	shale, siltstone
452	355	Ms	Hot Springs	shale, siltstone, pyrite
453	104	Ms	lower	shale
454	19	p€i	RR aggregate	rhyolite porphyry (from Missouri)
455	44	Om		shale, siltstone
456	46	Om		shale, siltstone
457	110	Ocm/Om		shale
458	91	Om		shale, siltstone, limy
459	141	Ow		shale, siltstone
460	584	Om		shale, siltstone, limy
461	106	Om		shale
462	90	Om		shale, siltstone, limy
463	95	Om		shale

Sample	Hg (ppb)	Formation	Part	Lithology
464	102	Ocm		shale, chert
465	93	Om	lower	shale, siltstone, limy
466	41	Ocm		shale, chert, limestone, sandstone
467	31	Om		shale
468	34	Ms	Hatton Tuff	tuff
469	25	Ki	pluton	nepheline syenite, pegmatite
470	18	Ki	pluton	nepheline syenite
471	89	Tw		sand, lignite
472	248	Tw		clay, lignite
473	73	Tw		clay
474	22	Pj	middle	shale
475	43	Pj	middle	shale, sandstone
476	73	Pj	lower/lower	shale, sandstone
477	26	Ms	lower	shale
478	25	Pj	middle	shale, sandstone
479	101	Ms	upper	shale, chert
480	16	Pj	middle	shale, sandstone
481	no data			
482	35	Pj	middle/lower	shale, siltstone, sandstone
483	248	Obf		chert, quartz veinlets
484	163	Om		shale
485	25	Ks		chalk, marly
486	20	Ks		chalk, marly
487	11	Kb		sand, silt
488	22	Kb		clay, sand, gravel
489	57	Kb		clay, siltstone, carbon
490	28	Pj	upper	sandstone, siltstone
491	10	Pj		sandstone, siltstone
492	3	Pjv		sandstone
493	9	Pj	upper	sandstone
494	167	Pa	lower	shale, sandstone
495	134	Pjv		shale, sandstone
496	43	Pjv		shale, sandstone
497	76	Pj		shale, sandstone
498	379	Pj		shale, siltstone
499	25	Ms	upper	shale, sandstone
500	313	Ms	middle/lower	shale, sandstone
501	174	Pj	upper	shale, siltstone, sandstone
502	155	Ms	upper	shale, sandstone
503	no data			
504	59	Pjv		shale, sandstone
505	140	Pj		sandstone, shale
506	43	Pa	lower	shale, sandstone
507	15	Pj		shale, sandstone
508	40	Kto		sand, clay, gravel
509	62	Kto		silt, carbon rich
510	152	Ms	lower	shale, sandstone, siltstone
511	38	Ms	lower	shale, sandstone, siltstone
512	29	Ms	lower	shale, cone-in-cone concretion
513	45	Ms	lower	shale, sandstone, siltstone
514	59	MDa	upper	chert, shale, sandstone
515	28	Obf		chert
516	105	Oby		shale, chert, conglomerate

Sample	Hg (ppb)	Formation	Part	Lithology
517	86	Ms	lower	shale, sandstone, siltstone
518	409	MDa	middle	chert, shale
519	36	Ms	middle/lower	shale, sandstone
520	71	Ms	upper	shale, sandstone
521	45	Ms	upper	sandstone, shale
522	65	Ms	upper	shale, sandstone
523	34	Ms	lower	shale, sandstone
524	50	MDa	middle	chert, shale, pyrite
525	41	Ms	middle	shale, sandstone, siltstone
526	29	Ms	middle	shale, sandstone
527	18	Ms	middle	shale, sandstone
528	195	Om		shale, siltstone
529	105	Oby		shale, sandstone, siltstone
530	781	Obf		chert, siltstone
531	881	Obf		chert, siltstone
532	181	Ow		shale
533	56	Om		shale
534	309	Obf		chert
535	52	MDa		shale, chert
536	30	Ms	middle	shale, sandstone
537	213	Ms	upper	shale, chert
538	86	ℙj	lower	shale, sandstone
539	37	ℙj	lower	shale, sandstone
540	49	ℙj	lower	shale, sandstone
541	91	Ms	upper	shale, cone-in-cone concretion
542	18	Ms	lower	shale, siltstone, sandstone, cone-in-cone concretion
543	34	Ms	lower	shale, siltstone
544	28	Ms	lower	shale, siltstone
545	117	MDa		shale, chert
546	8	Smm/Opc		shale
547	82	Opc		shale
548	57	Obf		chert, shale
549	26	Smm		shale, siltstone
550	46	Smm/MDa		shale
551	181	Opc		shale, siltstone
552	34	Sbl		shale, siltstone
553	266	Opc		shale
554	91	Obf		chert
555	17	Kt	DeQueen	gypsum, limestone, shale
556	53	Kt		marl, clay, gravel
557	98	Ms	upper	shale, sandstone
558	134	Ms	upper	shale, cone-in-cone concretions
559	34	Ms	middle	shale, sandstone
560	90	ℙj	lower	shale, sandstone
561	145	Ms	upper	chert, sandstone
562	109	Ms	lower	shale, sandstone
563	29	ℙj	lower	shale, sandstone
564	41	Ms	middle	shale, siltstone
565	24	Ms	lower	shale
566	105	Ms	lower	shale, siltstone
567	39	Ms	lower	shale, siltstone
568	81	Ms	lower	shale, siltstone
569	727	Ms	lower	shale

Sample	Hg (ppb)	Formation	Part	Lithology
570	2413	Ow	upper	siltstone, chert, shale
571	493	Ow	upper	limestone, siltstone
572	993	Ow		shale, black
573	363	Oby		shale, sandstone
574	51	Om		shale, siltstone
575	39	Om		shale
576	129	Opc		shale,
577	54	Ms	lower	shale, siltstone
578	27	Ms	lower	shale, siltstone
579	83	Opc		shale
580	61	Ow		limestone, shale
581	30	Ow		shale
582	50	Ocm/Om		shale
583	21	Om		shale, siltstone
584	146	OꞒc		shale, siltstone
585	279	OꞒc		shale
586	48	Ocm		shale
587	163	Ow		shale
588	447	Ow	upper	shale, limestone
589	544	Om		shale
590	73	Om		shale, sandstone
591	634	Ow		shale
592	126	Oby		shale
593	21	Om		shale, quartz veinlets
594	508	Oby		shale, chert
595	70	Ocm/Om		shale, siltstone
596	118	Ocm/Om		shale, limy
597	105	Oby		shale, sandstone
598	46	Ms	lower	shale, siltstone
599	80	Obf	upper	chert, limy
600	337	Obf	lower	chert, shale
601	138	Oby		shale
602	203	OꞒc		shale
603	328	Ocm		shale, siltstone
604	38	Oby		shale, siltstone
605	43	Ow		shale, siltstone
606	38	Ow		shale, siltstone, limestone
607	48	Ocm		shale
608	29	Om		shale
609	293	Oby		shale, siltstone
610	287	Ow		shale
611	56	Oby	upper	shale, siltstone
612	126	Obf		chert
613	76	Ms	lower	shale, chert
614	52	Ms	middle	shale, siltstone
615	281	Ms	middle	shale
616	94	Oby	upper	shale
617	1150	Ow	upper	shale, black
618	178	ℙa	lower	shale
619	54	ℙjv		shale
620	40	ℙjv/ℙa		shale, silty
621	51	Ms	middle	shale
622	94	MDa	middle	chert, shale

Sample	Hg (ppb)	Formation	Part	Lithology
623	211	Ow		shale, siltstone
624	118	Om		shale
625	244	Ms	lower	shale
626	111	Ms	lower	shale, silty
627	40	Sbl		shale, sandstone
628	84	Ms	lower	shale, siltstone
629	29	Ms	middle	shale, sandstone, silty
630	329	Ms	middle	shale, siltstone
631	72	Ms	middle	shale, siltstone
632	74	Ms	middle	shale
633	53	Ms	middle	shale
634	78	Ms	upper/middle	shale, silty
635	128	Ms	middle	shale, sandstone
636	74	ℙj	lower	shale, sandstone
637	17	Ms	upper/middle	shale, silty
638	171	Ms	lower	shale
639	73	Ms	upper/upper	shale
640	58	Kto		clay, sandy
641	690	Kt		limestone, carbon
642	116	ℙj		sandstone
643	3397	ℙj		shale, siltstone, (mercury mine area)
644	no data			
645	32	ℙa	lower	shale, siltstone
646	228	ℙa	lower	shale, siltstone
647	76	ℙj		shale
648	55	ℙjv		shale, siltstone, iron concretion
649	78	ℙjv		shale
650	57	Ms	upper	shale, siltstone
651	34	Ms	middle	shale
652	106	Ms	middle	shale, silty, fault gouge
653	245	Ms	lower	shale, sandstone, asphaltite
654	47	Ms	lower	shale, sandstone
655	691	Ms	middle	shale, siltstone
656	65	Ms	middle	shale
657	115	Ms	upper	shale, carbon
658	80	Sbl		shale, siltstone, sandstone
659	307	MDa	lower	shale
660	62	Ms	lower	shale
661	69	Ms	middle	shale, siltstone
662	73	Ms	upper/middle	shale
663	46	ℙj	lower	shale, sandstone
664	16	Kb		clay, sandy
665	20	ℙjv		shale, sandstone
666	55	ℙa	lower	shale
667	14	Kb		sand, gravel
668	37	ℙjv		shale
669	403	Ms	lower	chert, concretions
670	150	Oby		shale, silty
671	98	ℙa	lower/lower	shale, silty
672	242	ℙjv/ℙa		shale, siltstone
673	24	ℙjv		shale, siltstone
674	26	ℙjv		shale, siltstone
675	27	ℙj	middle	shale

Sample	Hg (ppb)	Formation	Part	Lithology
676	28	Kn		sand, glauconitic
677	50	Ms	lower	shale
678	41	Ms	middle	shale,
679	56	Ms	middle	chert, shale
680	49	Ms	middle	shale
681	54	Opc		shale, chert
682	6100	Obf		chert, black
683	277	Obf		chert, black
684	255	Obf/Opc		chert, shale
685	56	Obf	upper	chert
686	48	Ms	lower	shale
687	91	MDa		chert, novaculite, shale
688	179	MDa	middle	chert, novaculite, shale
689	23	MDa	middle	shale, chert, novaculite
690	72	Ms	lower	shale, chert
691	68	Ms	middle	shale
692	129	MDa		chert, shale
693	26	Smm		shale, sandstone, manganiferous oxides
694	893	Ow/Obf		chert, shale
695	30	Obf		chert
696	64	Om		shale
697	575	Obf		chert
698	245	Opc		shale
699	106	Om		shale
700	278	OЄc/Ocm		shale, chert
701	295	Ow/Obf		shale, chert
702	387	Om		shale, limestone
703	538	Om		shale, limestone
704	199	Om		shale
705	46	Om		shale
706	220	Om		shale, siltstone, limy
707	121	Om		shale
708	173	Om		shale, siltstone
709	447	Ow/Obf		shale, chert
710	23	Om		shale, siltstone
711	31	ℙjv		shale, siltstone
712	319	Ms	upper	shale, silty
713	37	ℙj	upper	shale, sandstone, conglomerate
714	53	Kt		clay, sand, gravel
715	111	ℙa	lower	shale, siltstone
716	50	ℙa	lower	shale, siltstone
717	34	Kt	Dierks	limestone, glauconitic, fossils
718	10	ℙa	lower	shale, sandstone
719	28	Ms	middle	shale, siltstone
720	63	Ms	middle	shale
721	60	Ms	middle	shale
722	45	ℙj	lower	shale, sandstone, iron oxides
723	33	Ms	upper	shale
724	29	Ms	lower	shale
725	61	Ms	lower/lower	shale
726	64	Ms	lower	shale
727	93	Ms	lower	shale
728	686	Oby		shale, siltstone