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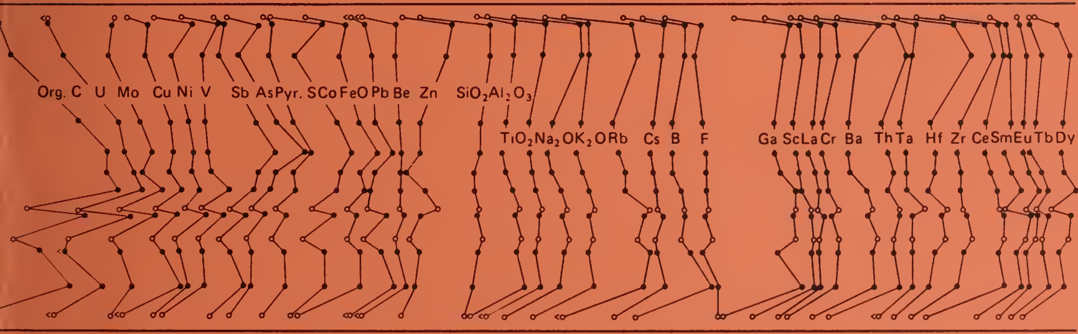
Chemical Composition and Geochemistry of the New Albany Shale Group (Devonian - Mississippian) in Illinois

Joyce K. Frost • David L. Zierath • Neil F. Shimp



Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

October 1985

Supplement to the Final Report
Prepared for the U.S. Department of Energy
Morgantown Energy Technology Center
Morgantown, WV

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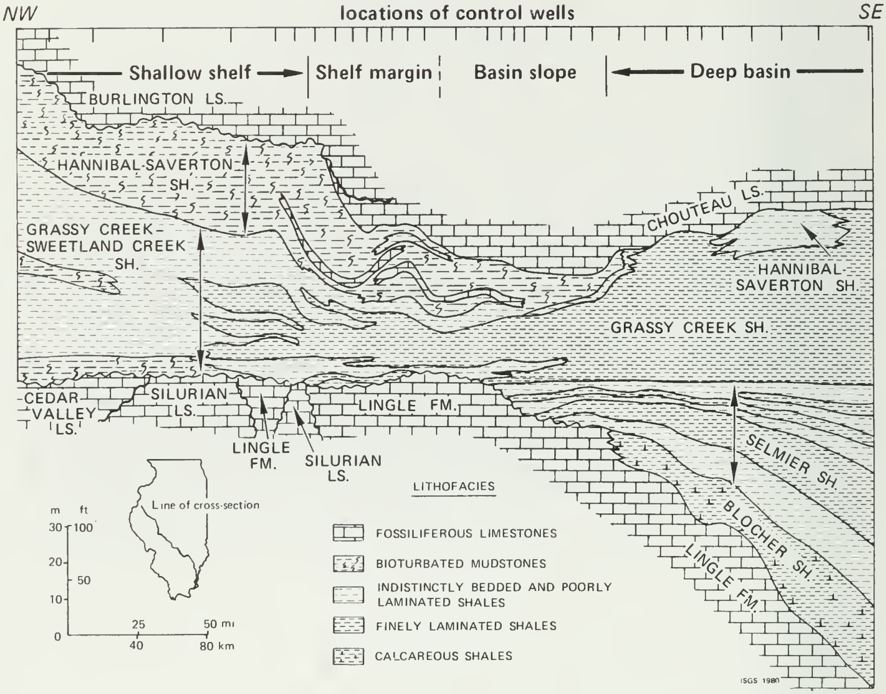
CONTENTS

Page

FIGURES

Page

TABLES



Frontispiece Diagrammatic cross section through the New Albany Shale Group in Illinois. (Figure VI-5 in Bergstrom, Shimp, and Cluff, 1980.)

CHEMICAL COMPOSITION AND GEOCHEMISTRY OF THE NEW ALBANY SHALE GROUP (DEVONIAN-MISSISSIPPIAN) IN ILLINOIS

ABSTRACT

In connection with geologic and other geochemical studies of the New Albany Shale Group (Devonian-Mississippian) in the Illinois Basin, 392 shale samples were analyzed for major and minor element composition, and 38 trace elements. There were 230 samples from 15 cores and 162 well cuttings. The results constitute the most extensive set of chemical data ever compiled for the New Albany in Illinois; they are sufficient to permit some interpretation of geochemical associations in these rocks.

Besides significant organic carbon content, black shales of the New Albany Group are characterized by enrichment in pyritic sulfur and in certain trace elements: U, Mo, As, Sb, Se, Cu, Ni, and V. There was slight enrichment with cobalt and lead. Enrichment in zinc and silver was sporadic--occurring mostly in samples from the deep basin of southeastern Illinois. Average ranges of concentration of these elements were as follows: organic C, 1% to 8.5%; S (which was nearly all pyritic), 0.5% to 3.5%; U, 3 to 39 ppm; Mo, <3 to 96 ppm; As, 4 to 45 ppm; Sb, 0.5 to 5 ppm; Se, <1 to 14 ppm; Cu, 20 to 170 ppm; Ni, 25 to 140 ppm; V, 80 to 350 ppm; Co, 9 to 30 ppm; Pb, 3 to 63 ppm; Zn, 25 to 450 ppm; and Ag, <0.1 to 0.8 ppm. Maximum concentrations were about twice these values.

The reducing conditions in the basin that led to the preservation and accumulation of organic matter probably also led to the reduction of uranyl species and their sorption onto clays and organic material. Enrichment of Cu, Ni and V may be related in part to formation of organo-metallic complexes. Enrichment of the other elements, and some of the enrichment of Cu, Ni, and V, appears to be related to the high levels of sulfide ion present in the strongly reducing marine environment of shale deposition. Pyrite occurs in each shale unit, and arsenic, antimony, and cobalt are associated with it.

The order of increase in organic carbon content, pyritic sulfur content, and trace metal enrichment was from the Hannibal-Saverton to the Sweetland Creek-Selmier, to the Blocher, and to the Grassy Creek Shale. Copper, nickel and vanadium were exceptions; their concentrations were highest in the Blocher Shale.

In the deep part of the Illinois Basin in southeastern Illinois, the upper part of the Grassy Creek Shale is characterized by higher than usual enrichment in Se, Sb, V, Zn, and Ag.

Correlation analyses of the chemical data indicated a detrital or clay minerals fraction in the New Albany Shale characterized by Al, K, Ti, Rb, Cs, Sc, Ga, Cr, Ba, Th, Ta, Hf, Zr, La and Ce; it included some of the Si, Fe, and Mg and, sometimes, Na, B, Be, and F. In the Hannibal-Saverton Shale the elements in the detrital minerals correlated together into two groups, a potassium-aluminum group that included Ga, Rb, Cs, Sc, Be, F, Fe, and Co, and a sodium-silicon group that included Ti, Zr, Hf, Ta, Th, Ba, La, and Ce.

Carbonates are present in each shale unit and highest in the Blocher, which contains appreciable dolomite as well as calcite. Manganese and strontium are included in the carbonate fraction. Appreciable phosphorus, probably present as calcium phosphate or apatite, was encountered in a few samples, and these also contained high fluoride and rare earth elements. Correlating with organic carbon in the organic or black shale fraction were pyritic sulfur and the trace elements with which these shales are enriched.

INTRODUCTION

This report presents the results of analyses for major, minor and 38 trace elements in 392 shale samples. They were analyzed in connection with the geologic and geochemical studies of the New Albany Shale Group (Devonian-Mississippian) in Illinois conducted by the Illinois State Geological Survey under contract to the U.S. Department of Energy. The principal purpose of the project was to define the extent of the New Albany Shale and to gauge its potential for yielding hydrocarbons, particularly natural gas. The chemical constituent most related to the hydrocarbon-resource potential of black shale is organic carbon. In 1980, Frost reported on the organic carbon content of the shales as part of the main report by Bergstrom, Shimp, and Cluff (1980).

The purpose of determining the other major and minor constituents and a large number of trace elements in the shale samples was to obtain data to evaluate (1) the potential economic importance of trace element concentrations in organic-rich shales; (2) new geochemical exploration techniques for natural gas; (3) trace element enrichment in shale organic matter; (4) the occurrence of heavy metal sulfides in shale; (5) potential catalytic effects of trace elements on shale pyrolysis yields; and (6) potential disposal problems.

In general, black shales accumulate slowly in a strongly reducing, marine environment rich in organic matter, and they contain high sulfide levels as well as organic matter. It is also well known that black shales are enriched in certain minor and trace elements; Mason (1958) gave the following list: V, U, As, Sb, Mo, Cu, Ni, Cd, Ag, Au, and metals of the platinum group. In some black shale basins some trace elements, particularly uranium and vanadium, may be concentrated to levels of potential economic importance; but such levels were not expected for any metal in the New Albany of the Illinois Basin. Confirmation of this was a secondary goal in determining their concentrations.

Also, if New Albany Group shales are considered for use as oil shales, knowing their elemental contents, particularly the heavy metal sulfide content, would be useful (1) for estimating catalytic effects of trace elements on shale-pyrolysis yields, and (2) for resolving problems with the disposal of spent shale. These shales were not expected to be very valuable as oil shales; however, this report details their heavy metal and sulfide contents. There are many data for those areas of the basin that have shales with the highest organic content, that is, the areas with the most potential for hydrocarbons.

The New Albany Group shales are gas bearing, more so in the southeastern part than in western and northern areas of the basin. If the variation in gas-bearing potential could be related to patterns of trace element enrichment or to other geochemical properties of the shales, a geochemical technique for exploration for natural gas might be developed.

Primarily, the data in this report provide a basis for elucidating the origin and evolution of these sedimentary rocks. Complete analysis for major, minor, and trace elements on a large number of samples is required to adequately characterize the rocks and interpret the sedimentary sequence in a black shale basin.

Literature Reports on Oil Shale

There is a great deal of literature on the chemistry and geochemistry of black shales. Vine and Tourtelot (1970) assembled the results of chemical analyses of several hundred samples of black shale and organic-rich rocks that are transitional with black shale. Samples representing a wide variety of depositional environments were used to define metal-rich black shale and to describe its occurrence and geochemistry. From a statistical analysis of their data, they found the elements are correlated in several groups: (1) a detrital mineral fraction, (2) a carbonate fraction, and (3) an organic fraction locally enriched in the mobile elements Ag, Mo, Zn, Ni, Cu, Cr, and V and less commonly in other elements. Vine and Tourtelot considered the source of these metals to be the higher-than-normal concentrations in seawater and the mechanism to be "an accumulative process beginning with the living organism and continuing throughout the periods of decay, burial and exposure to ground waters of various compositions throughout the history of the deposit."

Holland (1979) discussed further the source of metals in black shale deposits. Using the data of Vine and Tourtelot and data on deposits such as the Black Sea sediments studied by other investigators, he showed that enrichment of sediments was consistent with the removal of metals (whether by precipitation, chelation, or adsorption) from ordinary seawater, given present-day concentrations of the metals.

Brumsack (1980) studied Cretaceous black shales in cores from the Atlantic Ocean Deep Sea Drilling Project. He also concluded that the heavy-metal enrichments found could be accounted for by precipitation of these elements from normal seawater. His hypothesis for the mechanism of metal enrichment of sediments containing organic matter is outlined in the following quote: "The anoxic environment preserves organic materials from being oxidized, forms the condition for sulfate-reducing bacteria, which occurrence leads to the precipitation of heavy-metal sulfides" (Brumsack, 1980).

Swanson (1961) reported the occurrence and enrichment of uranium in thousands of samples of marine black shales from various formations in the United States. He discussed the incorporation of uranium from ordinary seawater. Chemically, uranium is not precipitated as a sulfide; but, as Swanson reported, the hydrogen sulfide that occurs in the acidic reducing environment in which organic matter is accumulating in sediments effects the reduction of the uranium in the water from the hexavalent to the tetravalent state. As uraninite, the uranium is precipitated onto the organic-rich sediment. In addition, uranium may be directly sorbed from water by organic materials, particularly by humus or humic acids.

Desborough, Pitman and Huffman (1976) reported the concentration and mineralogical occurrences of many elements in the "oil shales" of the Green River Formation, Piceance Creek Basin, Colorado, and Uinta Basin, Utah. They determined the principal residence of the major and minor elements in the minerals quartz, feldspar, pyrite, calcite, dolomite, and siderite; sulfur occurred in organic material as well as in pyrite. They deduced also that boron probably resided principally in K-feldspar, fluorine in fluorite and cryolite, manganese in the carbonates, zinc as its sulfide, and arsenic, nickel and cobalt in pyrite. The Green River Formation consists of marl-type rocks rather than argillaceous shale and was deposited in a lacustrine rather than a marine environment, so there are aspects of the Green River Formation that should not be compared to characteristics of true black shale basins. However, such features as accumulation of detrital material and diagenetic processes involving clay minerals and pyrite are likely to be similar in the two systems.

These examples of the literature on black shales illustrate the aspects of their geochemistry that can be well addressed with respect to the New Albany Group in this report with the extensive data presented.

EXPERIMENTAL

The 230 samples taken for chemical analysis from 15 cores drilled through the New Albany Shale were selected, processed, and prepared as described in the main report by Bergstrom, Shimp and Cluff (p. 13, Section III, 1980). The 162 samples of well cuttings were finely ground and air dried.

Methods of Analysis--Accuracy and Precision

Analytical methods are listed in table 1, and analytical procedures are described in Appendix A.

As described fully in Appendix A, there was discontinuity in the analyses by optical emission spectroscopy. Direct-reading optical emission spectroscopy (OED) was employed to analyze about half of the shale samples, S00001 to S00205, then was discontinued. Photographic optical emission spectroscopy as performed by one group of analysts (OEP-1) was used to analyze shale samples S00001 to S00238. Some months later, photographic optical emission analyses were resumed by a new group of analysts who used a modified procedure, OEP-2, to analyze the last half of the samples, S00239 to S00430.

Many elements could be determined by more than one method; therefore, the results judged to be most accurate could be selected for each element. The accuracy and precision by each method can be judged from the results on three shale reference standards as listed in tables 2, 3, and 4.

The results for iron as determined by wavelength-dispersive X-ray fluorescence analysis, for potassium and manganese by neutron activation analysis, and for zirconium by energy-dispersive X-ray fluorescence spectroscopy appeared to be consistent as well as accurate. They were taken almost exclusively for the final values on the samples.

Total sulfur could not be accurately determined by X-ray fluorescence analysis. There were three samples for which not enough material was available for a reliable analysis by the gravimetric method, so the X-ray fluorescence results were used. These results are noted in Appendix C. They are perhaps low by 10% to 15%.

TABLE 1. Methods of analysis and elements determined in Devonian shales.

Method	Elements
Wavelength-dispersive X-ray fluorescence spectroscopy (XRF)	Si, Al, Fe, Mg, Ca, K, Ti, P, Cl, (S)
Instrumental neutron activation analysis (NAA)	Fe, Na, K, As, Ba, (Br), Ce, Co, Cr, Cs, Dy, Eu, Ga, Hf, La, Lu, Mn, Mo, (Nd), Ni, Rb, Sb, Sc, Se, Sm, Sr, Ta, Tb, Th, U, (W), Yb, Zn
Photographic optical emission spectroscopy (OEP)-1	Ag, Be, Co, Cr, Cu, Ge, Mn, Ni, Pb, Sn, V, Zn, Zr
-2	+ B, Mo, Sr
Optical emission spectroscopy--direct-reading instrument (OED)	B, Be, Co, Cr, Cu, Ge, Mo, Ni, Sn, Sr, V, Zn, Zr
Energy-dispersive X-ray fluorescence spectroscopy (XES)	Ba, Ce, Sr, Zr
Combustion method (Comb.)	Total C and total H
Wet-chemical methods	Inorganic C
(Grav.)	Total S
	Pyritic S and sulfate S
Ion-selective electrode analysis (ISE)	F

Analyses for neodymium by instrumental neutron activation analysis were generally imprecise and inaccurate, so all the results were omitted. Sensitivity by neutron activation analysis was not sufficient to detect bromine and selenium in most of the shale samples, and many "less than" values appear for each element in the table of data. Results for bromine are probably only informative of the bromine level in the shales of the New Albany Group. The selenium concentration in most samples was below the detection limit of 1 to 5 ppm, but several samples contained significantly more. Because nearly all the latter were from one area of the basin, these few selenium data are considered quite important. Results for tungsten are reported only for samples from the Hardin County (11IL) core; they contained tungsten at levels that could be reliably determined. In nearly all of the other samples, tungsten was at the level of 1 to 2 ppm or less, which was near the detection limit, and the data are not considered useful.

In the selection of final concentration values for other trace elements determined by more than one method of analysis, often no method appeared superior. Final values were usually averages of the results by the different methods. For some trace elements, selection was weighted to favor the method that appeared from the results on the reference shales to generally give more accurate, more precise, or more consistent values. For example, the barium

TABLE 2. Concentrations of elements determined in U.S. Geological Survey rock standard Cody Shale, SCo-1.

	Method of analysis*				
	NAA	OED	OEP-1	Other	Literature†
Fe_2O_3(%)	5.34±.17 (9)				5.13±.07 (6)
Na_2O(%)	.97±.05(17)				.86±.12 (7)
K_2O (%)	2.80±.09(17)				2.75±.10 (6)
F				ISE 534±13(3)	750-1500(3)
Be		1.7±.3(3)	2.0±.3(3)		1.7±.2 (3)
B		56±2			68±4 (4)
Sc	13.9±.3 (9)				10.6±.9 (6)
V		110±4	154±21		122±16 (8)
Cr	66±2 (9)	62±1	64±1		67±5 (6)
Mn	413±19 (8)		357±1		420±40 (8)
Co	11.0±.3 (9)	11.9±.2	9.5±.5		10±1 (9)
Ni	36±11 (8)	21±1	25.7±1.5		28±2 (7)
Cu		23±1	31±6		30±2 (8)
Zn	107±15 (9)	95	96±2		106±9 (9)
Ga	17.6±1.3 (9)				12±2 (4)
Ge		3.3±.2	<5.4		<1.0
As	13.4±.4 (9)				11-54 (2)
Se	1.0±.4 (9)				.85 (2)
Br	1.4±.5 (7)				
Rb	111±6 (9)				118±9 (5)
Sr	190±50 (17)	152±5		XES 143	188±26 (11)
Zr		208±4	226±19	XES 163	160±24 (6)
Mo		.5	4.5±.1		1.3±.1 (3)
Ag			<1		.019,.126(2)
Sn		3.7±.3			4.1 (2)
Sb	2.3±.1 (9)				2.51±.06 (6)
Cs	7.1±.2 (9)				7.5±.5 (4)
Ba	586±85 (11)			XES 714	580±100(11)
La	34.1±.6 (9)				35±10 (4)
Ce	55±2 (9)			XES 43	62±6 (6)
Nd	34±5 (7)				26±2 (6)
Sm	6.1±.3 (9)				5.3±.4 (4)
Eu	1.29±.06(17)				1.2±.2 (5)
Tb	.72±.07 (7)				.75±.04 (4)
Dy	4.5±.4 (8)				3.8 (2)
Yb	2.0±.1 (9)				2.6±.3 (6)
Lu	.37±.03 (9)				.37 (2)
Hf	4.9±.4 (9)				4.26±.10 (4)
Ta	1.00±.08 (9)				.91±.08 (4)
W	1.4±.4 (7)				1.61 (1)
Pb			21±1		29±2 (4)
Th	9.4±.3 (9)				10.1±.7 (5)
U	3±1 (6)				3.09±.14 (4)

Note: Concentration, in ppm unless % specified, and standard deviation for the number of determinations in parentheses.

* NAA, instrumental neutron activation analysis; OED, direct-reading optical emission spectroscopy; OEP-1, photographic optical emission spectroscopy, group 1 (see text); ISE, ion-selective electrode analysis; XES, energy-dispersive X-ray fluorescence spectroscopy.

† Gladney and Goode (1981).

TABLE 3. Concentrations of elements determined in U.S. Geological Survey reference Devonian Ohio Shale, SDO-1.

	Method of analysis*							
	XRF	NAA	OED	OEP-1	OEP-2	Other		Literature†
SiO_2(%)	49.91±.19 (3)							49.8±.4 (7)
Al_2O_3	12.04±.16							12.6±.8 (7)
$FeO^{\dagger\dagger}$	8.41^{**}	8.50±.27(7)				AAS	8.75±.04 (3)	8.62±.20(7)
MgO	1.29±.10							1.54±.15(7)
CaO	1.01±.04							1.04±.09(8)
Na_2O		.39±.05						.34±.02(6)
K_2O	3.06±.02	3.45±.19						3.41±.06(7)
TiO_2	.74±.01							.68±.05(6)
P_2O_5	.10±.02							.11±.01(6)
S						Grav.	5.25	5.42±.15(7)
Cl	.009±.002							
CO_2							1.23±.09	1.16±.14(4)
Organic C						(Diff.)	10.19	10.13
F						ISE	.059±.003	
H_2O-							.73	
N_2							.31	.35±.04(6)
Pyritic S						Grav.	5.42	
Sulfate S						Grav.	.06	
Total H						Comb.	1.45±.01	1.40±.04(6)
Total C						Comb.	10.53±.01	10.45±.2 (8)
Li(ppm)						AAS	31±.8 (3)	25±6 (3)
Be			3.4±.2 (3)	5.5±.2(3)	5.3±1.0 (10)			
B			120±6		140±19			
Sc		15.2±1.3						12,16 (2)
V			160±4	200±4	64±10			177±24 (5)
Cr		61±4	56±2	89±2	50±9			61±6 (5)
Mn		332±10		340±6	230±47			340±31 (8)
Co		44±3	49±1	56±2	35±5			46±7 (5)
Ni		98±19	97±1	135±3	61±7	AAS	82±1	96±8 (6)
Cu			73	74±1	55±13	AAS	63±1	63±2 (6)
Zn		67±14	110±5	76±6	77±12	AAS	55±1	65±9 (7)
Ga		19±1						17.6±1.5(3)
Ge			1.4±.2	<11	2.5±.2			
As		79±4						82±22 (3)
Se		1.9±.7						

TABLE 3. Continued.

	Method of analysis*							
	XRF	NAA	OED	OEP-1	OEP-2	Other		Literature†
Br		3.6±.5						
Rb		127±15						132,136 (2)
Sr		93±30	70±1		85±10	XES	78	76±11 (5)
Zr			130±5	380±10	94±13	XES	181	152±28 (5)
Mo		157±15	190±4		160±37			156±34 (3)
Ag				<.7	.061±.015			
Sn			<1	<1.5	6.3±.7			
Sb		4.4±.3						
Cs		5.7±.5						
Ba		550±70				XES	525	525,562 (2)
La		42.8±1.9						44,41 (2)
Ce		77.4±7.8				XES	65	
Nd		45.6±8.3						
Sm		8.7±.6						
Eu		1.9±.2						
Tb		1.2±.1						
Dy		7.1±.6						
Yb		2.9±.3						3.1,2.5 (2)
Lu		.54±.06						
Hf		4.6±.5						
Ta		1.1±.1						
W		1.6±.5						
Pb			38±1.7	11±.5	37±4	AAS	33±7	38±4 (5)
Th		9.5±.7						9.7±.8 (3)
U		52±4						50±5 (3)

Note: Concentration in %, then in ppm, in listing, and standard deviation for number of determinations in parentheses.

* XRF, wavelength-dispersive X-ray fluorescence spectroscopy; NAA, instrumental neutron activation analysis; OED, direct-reading optical emission spectroscopy; OEP-1 and OEP-2, photographic optical emission spectroscopy, groups 1 and 2 (see text); AAS, atomic absorption spectroscopy; ISE, ion-selective electrode analysis; Grav., wet-chemical method with precipitation.

† Round-robin analyses by Eastern Gas Shales contractors; results reported to A. E. Hunt, Morgantown Energy Technology Center, Morgantown, W. Va., April 20, 1978.

†† Total iron.

** Revised value; former value 7.74±.14.

TABLE 4. Concentrations of elements determined in Indiana Geological Survey reference Indiana Shale, SIND-1.

	Method of analysis*					Ind. Geol. Survey†			
	XRF	NAA	OED	OEP-1	Other	AAS	ICP	XRF	Other
SiO_2(%)	52.37±.50(3)					50.34±.15	52.4		
Al_2O_3	14.59±.42					14.38±.08	14.7		
FeO††	3.51±.12	3.53±.33 (4)				3.45±.04	3.69		
MgO	1.98±.06					2.59±.04	2.58		
CaO	3.10±.08					3.06±.05	3.25		
Na_2O		.39±.004(6)				.55±.02	.40		
K_2O	4.15±.03	4.62±.07 (6)				4.56±.02	4.31		
TiO_2	.64±.01					.88±.01	.70		
P_2O_5	.08±.01					.102±.001	.10		
S					Grav. 1.57±.06				1.56±.03
Cl	.01								
CO_2					3.59±.06				3.77±.18
Organic C					Diff. 8.05				8.0±.1
F					ISE .12				
H_2O-					1.26±.04				1.27±.06
Pyritic S					Grav. 1.40±.04				
Sulfate S					Grav. <.01				
Total H					1.36±.02				1.34±.06
Total C					9.03±.14				9.0±.1
Be(ppm)			2.3±.1(3)	5.2±.2(3)					
B			200±12						
Sc		19±1.4 (4)							
V			280±10	310±12			259		
Cr		98±11 (4)	120±1	140±7		84	98		
Mn		294±3 (8)		330±20		300	260		
Co		16±1.6 (4)	22±.5	20±.5					
Ni		116±22 (4)	110±3	153±6		107	102		
Cu			180±10	154±4		175	184		
Zn		138±26 (4)	150±9	165±7		162	162		
Ga		20±.8 (4)							
Ge			.84±.08	<11					

TABLE 4. Continued.

	Method of analysis*					Ind. Geol. Survey†			
	XRF	NAA	OED	OEP-1	Other	AAS	ICP	XRF	Other
As		16±1 (4)							6.9
Se		3.8±.7 (4)							
Br		2.8±.7 (4)							
Rb		156±13 (4)						145	
Sr			110±4		XES 100	117	120	115	
Zr			79±5	276±13	XES 140			110	
Mo		26±12 (4)	18±1			25	25		
Ag				<.72					
Sn			18±.6	6.4±.5					
Sb		2.7±.3 (4)							
Cs		8.3±1.1 (4)							
Ba		427±51 (11)			XES 466	418	430		
La		37±2 (4)							
Ce		72±6 (4)			XES 63				
Sm		8.8±.4 (4)							
Eu		1.8±.1 (7)							
Tb		1.1±.1 (4)							
Dy		6.1±.1 (6)							
Yb		2.6±.2 (4)							
Lu		.44±.13 (4)							
Hf		3.4±.5 (4)							
Ta		1.0±.04 (4)							
Pb			10±1	15±.3		43	57		
Th		9.5±.9 (4)					10		
U		9.3±1 (4)							

Note: Concentration in %, then in ppm, in listing, and standard deviation for number of determinations in parentheses.

* XRF, wavelength-dispersive X-ray fluorescence spectroscopy; NAA, instrumental neutron activation analysis; OED, direct-reading optical emission spectroscopy; OEP-1, photographic optical emission spectroscopy, group 1 (see text); Grav., wet-chemical method with precipitation; ISE, ion-selective electrode analysis; XES, energy-dispersive X-ray fluorescence spectroscopy.

† Lechler and Leininger (1978) and Lechler, Roy, and Leininger (1980). Analyses by methods indicated: AAS, atomic absorption, ICP, inductively coupled plasma emission, XRF, X-ray fluorescence spectroscopy, and by other methods including arsenic by colorimetric method.

†† Total iron.

value determined by energy-dispersive X-ray fluorescence spectroscopy was generally more accurate than the value determined by neutron activation analysis. Low concentrations of molybdenum (less than about 50 ppm) could be determined adequately by direct-reading optical emission spectroscopy, whereas determinations by neutron activation analysis lacked sensitivity at that level. On the other hand, the results by neutron activation analysis were considered more accurate for high molybdenum concentrations.

The results obtained by optical emission spectroscopy presented some problems. It had been expected that optical emission would provide reliable concentration data for Ag, B, Be, Cu, Ge, Mo, Ni, Pb, Sn, V, and Zn and confirmation analyses for other elements listed in table 1. The analyses by direct-reading optical emission spectroscopy for B, Be, Co, Cr, Cu, Mo, Ni, Sr, V, and Zn were considered satisfactory because results on the reference shale standards were satisfactory. Also, results on samples for Co, Cr, Mo, Ni, and Zn generally agreed with results by neutron activation analysis (which is not the best method for determination of Mo, Ni, and Zn); and strontium results agreed well with values obtained by energy-dispersive X-ray fluorescence analysis. As described before, however, only approximately half the shale samples (S00001 to S00205) were analyzed by direct-reading optical emission spectroscopy. Concentrations obtained by photographic optical emission spectroscopy on the first half of the shale samples (OEP-1) were satisfactory for manganese and zinc, but appeared to be too high on many samples for cobalt, chromium, and nickel, and too low for lead. Values for chromium, strontium and zinc on the last half of the shale samples obtained by photographic optical emission analysis (OEP-2) agreed well with the results by neutron activation analysis for chromium and zinc and by energy-dispersive X-ray fluorescence spectroscopy for strontium.

In addition to analyzing reference shale SDO-1, the second group of analysts using photographic optical emission spectroscopy (OEP-2) analyzed standard reference coal NBS-1632 and fly ash NBS-1633 from the National Bureau of Standards for beryllium, silver and tin. Table 5 provides comparisons of their results on the NBS standards with literature values (Gladney, 1980). The comparison of the values for silver with the literature values is quite satisfactory, considering that these concentrations--and also the concentration of silver in the shales--are low for good analysis by optical emission spectroscopy.

TABLE 5. Concentrations of elements in NBS Standard Coal and Fly Ash determined by photographic optical emission spectroscopy, OEP-2.

	NBS-1632		NBS-1633	
	OEP-2	Gladney (1980)	OEP-2	Gladney (1980)
Be (ppm)	5.1	1.4±2	30	12±1
Ag (ppb)	73	60±15		
(ppm)			0.34	0.25±1.3
Sn (ppm)	9.3	<10-125	14	9.4±3.0

Satisfactory literature values for Be, B, Ge, Ag, Sn, and Pb in all the reference shales do not exist, so it is difficult to judge the accuracy of the values determined by the three different optical emission groups in this work, but the results from the three methods often did not agree with one another. Furthermore, there were differences in calibration from OEP-1 and OED to OEP-2; it appeared that analysis of a large group of shale samples by OEP-2 would not result in the same average concentration or the same scatter to the population of concentrations, particularly for copper and vanadium, as would analysis via OED or OEP-1. Therefore, results for Ag, B, Be, Cu, Ge, Pb, Sn, and V, which were determined only by optical emission spectroscopy, are not considered to be as reliable as those for the other elements.

Comparison of Data with Results from Other Illinois Basin Studies

Chemical studies of the New Albany Shale in Illinois, Indiana, and Kentucky have been carried out by several other contractors to the U.S. Department of Energy as part of the Eastern Gas Shales project. Other contractors have studied the same DOE cores as the Illinois Geological Survey.

To compare chemical data generated by different investigators for shales from different parts of the Illinois Basin, elemental analyses must be consistently accurate from one study to another. To judge that this is true, it is necessary but often not sufficient that various investigators obtain accurate results for reference shale materials, such as are described in tables 2 to 4. Extra effort is usually extended to the analysis of reference standards. The real test of accuracy is whether various investigators obtain similar results for routine analysis of samples from the same DOE cores. To be able to evaluate whether data from the Illinois Geological Survey may be compared with those from other investigators, it was, therefore, particularly useful that the Illinois Survey analyzed, for a large number of elements, samples from two other states--from cores from Christian County (01KY) and Bullitt County (02KY), Kentucky, and from Sullivan County, Indiana (01IN).

Only chemical analyses done by the Illinois and Indiana Geological Surveys are compared here. Samples of the core from Sullivan County, Indiana, obtained by the Illinois Survey were splits of those analyzed chemically by the Indiana Geological Survey, with data reported in Lechler and Leininger (1978). (In fact, the main purpose in obtaining samples from the Indiana core was not for an interlaboratory study but to obtain organic-rich samples from a deep part of the basin for surface area measurement and organic petrography studies.)

Comparison of results for samples from the Sullivan County core (Appendix B) and for the Indiana reference shale SIND-1 (table 4) shows that results for most elements analyzed by the two Surveys agree satisfactorily. Exceptions are cobalt and vanadium. Results for cobalt on the 01IN core samples obtained by the Indiana Geological Survey, using inductively coupled plasma emission spectroscopy, are significantly higher than those reported by the Illinois Survey; we are confident of our results, obtained via neutron activation analysis, for cobalt at all concentration levels. In the case of vanadium, confidence should be given to results reported by the Indiana Survey, at least compared to results by OEP-2, the second photographic optical emission spectroscopy method of the Illinois Survey--this was the method used for the analysis of the 01IN samples; there was a lack of sensitivity in the OEP-2 method to both high and low concentrations of vanadium.

Statistical Analyses

Statistical analyses were done on data on samples from a core or from the same stratigraphic unit. Calculation of mean value and standard deviation of elemental concentrations and correlation analyses were carried out on the University of Illinois IBM 370 computer using Statistical Analysis System (SAS) programs.

RESULTS

Appendix C contains the tabulated results of the chemical analyses.

Explanatory Notes to Appendix C

1. The cores from which samples were taken for chemical analysis are described in Section III of Bergstrom, Shimp, and Cluff (p. 10 to 14, 1980) and are listed in table 6, which has been taken from that report.

The geologic numbering system for the core samples is also described in Bergstrom, Shimp, and Cluff (p. 12, 1980). Briefly, the first four of the eight ciphers in the geologic number give the numerical order of the core taken in the state and an abbreviation for the state: IL, IN, or KY. The fifth and sixth characters specify the data set (10-foot intervals numbered successively from the top of the core) from which the sample was taken. The letter C in the seventh space indicates that the sample was taken principally for chemical analyses of off-gases and constituent elements; the letter L indicates a sample taken principally for lithologic studies. The number in the eighth position indicates whether this was the first, second, or third chemical or lithologic sample taken from that data set or 10-foot interval, and the sample is defined uniquely by depth to top of the sample.

The locations of the New Albany Shale (NAS) samples taken from well cuttings in Illinois are fully described in Bergstrom, Shimp, and Cluff (p. 14 to 16, 1980). Locations of all samples are shown in figure 1.

Samples S00136 (NAS-0021) and S00137 (NAS-0025) are outcrop samples from Section 25, T. 11S, R. 7E of Hardin County and Section 11, T. 12S, R. 2W of Union County, respectively, in Illinois.

Samples S00310 (NAS-0434) and S00311 (NAS-0438) are from Crittenden County, Kentucky, located 7704 feet from SL and 8119 feet from WL of 17-L-16.

2. Samples S00049 and S00050 from the Paint Creek bluff outcrop, east of Bainbridge, Ross County, Ohio, are from the Cleveland Member of the Ohio Shale. They were collected by R. D. Harvey as part of an investigation on the differential weathering of black shales (Harvey, 1977) and are included here only for completeness of the chemical data. Sample S00049 (71477A) was from a hard bed, and sample S00050 (71477B) from a soft bed of the outcrop. The clay minerals content of one sample did not differ significantly from that of the other, but sample A from the hard bed contained less iron (1.73% FeO) and more organic material (8.81% organic carbon) than did sample B from the soft bed (2.92% iron as ferrous oxide and 2.59% organic carbon). The greater organic content of the hard sample A may reflect strong reducing conditions in the history of the bed and thus a reduced state for the iron in the sample. In

TABLE 6. New Albany Shale cores sampled for chemical analysis.

Core designation	Well name	Location	County
Illinois			
▲ 01IL	Miller #1 G. W. Sample	SW SW NE 11-15N-3W	Sangamon
● 02IL	Tri-Star Prod. #1D Lancaster	SE SW NW 31-9N-4E	Effingham
△ 03IL	Superior Oil #C-17 H. C. Ford	C SW SE 27-4S-14W	White
● 04IL	No. Illinois Gas #1 RAR	SW SW NE 32-8N-4W	Henderson
△ 05IL	Peoples Gas #1 Witt	SE SE SW 19-16N-13W	Edgar
● 06IL	No. Illinois Gas #1 MAK	NE NE NW 8-23N-2W	Tazewell
△ 07IL	Benedum Trees #1 Van Zant	SW/C 24-6N-1W	Fayette
△ 09IL	Coral Oil #1 Schroeder	SE NW SE 6-3S-6W	St. Clair
△ 10IL	Helm Petroleum #1 Ballance	SW NE SW 12-4N-1W	Fayette
● 11IL	Rector & Stone #1 Missouri Portland Cement	NE NE NE 36-11S-7E	Hardin
△ 12IL	Hobson Oil #2 Taylor	SE NE NW 34-1S-7E	Wayne
● 13IL	G. T. Jenkins #1 Simpson	SW SE SW 17-3S-8E	Wayne
Indiana			
● 01IN	Energy Res. Indiana #1 Pheghly Farms	NW NW NE 14-6N-10W	Sullivan
Kentucky			
● 01KY	Orbit Gas #1 Ray Clark	650'NL 90'EL 12-G-25	Christian
● 02KY	Norm #1 Knievim		Bullitt

● = DOE-EGSP core
▲ = ISGS core (complete section)
△ = ISGS core (partial section)

the higher iron content and softer sample B, the iron may be in a more oxidized state and thus more weatherable (R. D. Harvey, personal communication).

3. Sample S00378 (11IL04L*) is a dike in sample S00377 (11IL04L1). The dike sample was not included in any of the averages, statistical analyses, or plots of the data from that Hardin County core.

4. The formation to which a sample belongs is listed by the American Association of Petroleum Geologists code with the following abbreviations: BLCR, Blocher Shale; CDVL, Cedar Valley Limestone: CHUT, Chouteau Limestone; CLCR, Clegg Creek Shale; CPRN, Camp Run Shale; DVNN, Devonian System; GCSC, Grassy Creek-Sweetland Creek Shale (undifferentiated); GRCK, Grassy Creek Shale; HBSV, Hannibal-Saverton Shale (undifferentiated); HNBL, Hannibal Shale; LNGL, Lingle Formation; LUSN, Louisiana Limestone; MGTR, Morgan Trail Shale; SDCK, Sweetland Creek Shale; SDMR, Sweetland Creek-Sylamore interface; SELM, Selmier Shale; SLMR, Sylamore Sandstone; SPGV, Springville Shale; SVRN, Saverton Shale; WRSW, Warsaw Shale.

5. The value of H_2O+ is a calculated concentration that accounts for the portion of the total determined hydrogen that is not present in the sample as moisture at 110°C, which is determined, or as hydrogen associated with the organic material. An average value of 0.12 x weight % organic carbon was used for the amount of hydrogen in the organic portion of the samples, except for those from the 11IL and 02KY cores. This value was the average (atomic H/C =

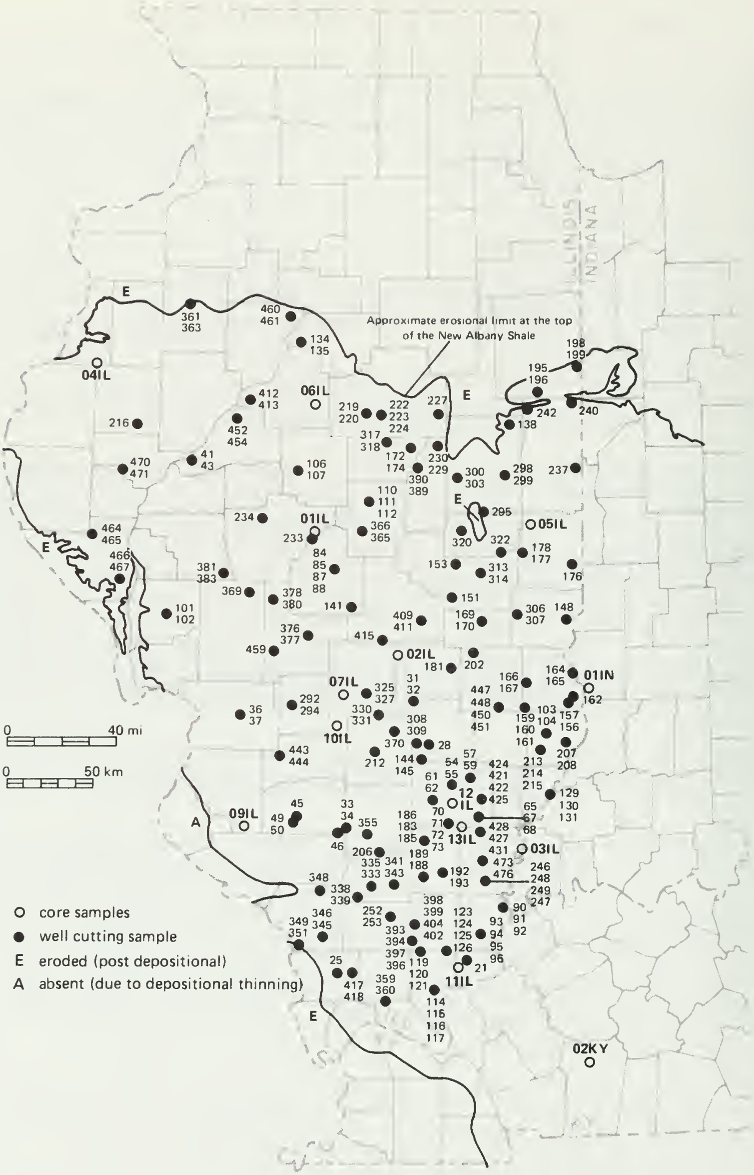


Figure 1. Location of New Albany Shale cores and well cutting samples taken for chemical analysis.

1.40) obtained by Dickerson and Chou (1980a) from analysis of the organic fractions obtained by extracting some 18 whole shale samples from the Illinois Basin with a mixture of benzene and methanol (70%:30% by volume) or with benzene. This is considered a reasonable approximation to the amount of organic hydrogen in the shales. The error associated with this approximation results from a high H/C ratio because only a small amount of the organic matter is extracted, and lower molecular weight compounds are favored in the extraction.

The organic matter in core 11IL from the Hicks Dome area of Hardin County is more metamorphosed compared to that in shales from other areas of the Illinois Basin (Dickerson and Chou, 1980b). Analysis of the kerogen fractions obtained for petrographic studies by acid-leaching of two samples from the Hardin County core gave an average atomic H/C = 0.8, or wt % organic H = 0.067 x wt % organic C (D. R. Dickerson, personal communication). Organic hydrogen thus calculated for each sample of the Hardin County core was subtracted from the total hydrogen determined in each sample, and the net hydrogen thus obtained was converted to water occurring as H_2O- and H_2O+.

Also, the atomic H/C of 1.40 in kerogen was not applicable to the Clegg Creek Shale at the top of the core from Bullitt County, Kentucky (02KY) because use of the ratio to calculate net inorganic hydrogen resulted in a negligible or negative value of H_2O+ in the samples. Results of analyses for carbon and hydrogen in the organic fraction of samples from cores from south-central Indiana and central Kentucky (Zielinski and Nance, 1978, 1979; and Smith and Young, 1967) indicate that a lower H/C applies to the organic fraction of shales in this region. The value atomic H/C = 1.17 in kerogen, which is equivalent to wt % H = 0.098 x wt % organic C and which was obtained as the average of the H/C means from the Adair County, Kentucky core of Smith and Young (1967) and the Clark County, Indiana core of Zielinski and Nance (1979), was used to calculate net hydrogen and thus H_2O+ for all samples of the Bullitt County core.

It is to be expected that H_2O+ content calculated for the batch of shale samples is only a reasonable estimate of the bound water and hydroxyl groups on clays actually present in each sample. H_2O+ content was not calculated for three samples. The average value of wt % organic H = 0.12 x wt % organic C used to calculate net inorganic hydrogen resulted in negative values, and better estimates of organic hydrogen in the three samples could not be had.

6. The total measured compositions of the samples were calculated by summing the concentrations of SiO_2, Al_2O_3, FeO (except for samples of core 01IL which contained appreciable sulfur as sulfate, so Fe_2O_3 was used), MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, MnO, V_2O_5, S (minus O ≡ S), Cl (minus O ≡ Cl), CO_2, organic C, organic H (equal to organic C x .12, except for core 11IL where organic H = 0.067 x wt % organic C, and for core 02KY where organic H = 0.098 x wt % organic C), F (minus O ≡ F), H_2O+, and H_2O-.

In the course of the chemical analyses of this large number of samples, many were rerun in order to achieve reasonable totals. Nevertheless, because the method of calculation of H_2O+ could result in significant error in the concentration of that component in any sample, and because organic carbon determined and organic hydrogen estimated do not represent all of the organic matter, greater deviation of the totals from 100% was allowed than is usually considered satisfactory in chemical analyses. Though most totals were between 98% and 101%, a few were as low as 96% or as high as 103%.

7. The N_2 and CO_2 internal surface area results presented in Appendix C are the tabulation of those data obtained on 206 samples by Thomas and Frost (1980). The experimental procedure is described by Thomas and Frost (1980). Briefly, the internal surface area measurements provide a measure of the porosity of the shales. The CO_2 surface area measures the surface area of pores with diameters greater than about 3.5 Å, but the N_2 surface area measures only that within pores with diameters greater than about 5 Å; the difference between the CO_2 internal surface area and the N_2 internal surface area represents the more difficultly accessible porosity. The larger the CO_2/N_2 internal surface area ratio, the slower is the rate of release of gaseous hydrocarbons from the sample, therefore, from a shale that contains natural gas.

Summary Statistics of Elemental Concentrations by Stratigraphic Unit

New Albany Shale Group samples were grouped according to stratigraphic unit in order to render the large amount of data on them comprehensible. Tables 7 to 10 present summary statistics for the concentrations of the elements in the main shale units: Blocher, Selmier and Sweetland Creek, Grassy Creek, and Saverton and Hannibal. The Hardin County core (11IL), from the region of Hicks Dome, exhibited such different concentrations for certain of the elements that it is treated separately. Statistics for it are summarized in table 11, and the core is discussed separately.

In tables 7 to 11, each analyte was determined in the given number of samples with results in the range from the minimum to maximum values listed. Also, the analyte was sought but was at or below the detection limit in the number of samples in the "No. <'s" column.

Distribution of Elements by Depth in Cores

In figures 2 to 9 are plotted the concentrations of the elements relative to depth for the eight DOE-EGSP cores; 01KY, Christian County, Kentucky (fig. 2); 02KY, Bullitt County, Kentucky (fig. 3); 02IL, Effingham County, Illinois (fig. 4); 04IL, Henderson County, Illinois (fig. 5); 06IL, Tazewell County, Illinois (fig. 6); 11IL, Hardin County, Illinois (fig. 7); 13IL, Wayne County, Illinois (fig. 8); and 01IN, Sullivan County, Indiana (fig. 9).

In these down-hole plots, elements with similar distribution patterns are graphed in sequence (nested) to emphasize the similar patterns. These plots permit easy visualization of the chemical composition of the cores and the geochemical associations of the elements in them.

DISCUSSION OF RESULTS

Most of the discussion of the New Albany Shale Group samples is based on their grouping by stratigraphic units. There is also some discussion of the data with respect to areal distribution of samples in the basin.

Elemental Concentrations in the Shale Units of the New Albany Group

The organic carbon content of each shale unit was described fully in Frost (1980). The Grassy Creek is the most organic-rich shale unit in the New

Albany Group in Illinois; the Blocher and Sweetland Creek-Selmier Shales average somewhat lower organic content. The Hannibal-Saverton Shale is lowest in organic material, averaging 1% to 2% in organic carbon.

From a study of the mean concentrations of the other major and minor components in the shales from the different units (tables 7 to 10) it is seen that the Sweetland Creek-Selmier, Grassy Creek, and Hannibal-Saverton Shales have about the same major and minor element composition, with similar concentrations of SiO_2, Al_2O_3 (and a similar SiO_2/Al_2O_3 ratio), FeO, MgO, CaO, Na_2O, K_2O, TiO_2 and P_2O_5, although the Hannibal-Saverton Shale has a significantly lower pyrite content (0.59% mean pyritic S) than have the other shale units. In contrast, the Blocher Shale contains appreciable calcite (10.1% CaO, 10.7% CO_2) and lower concentrations of the constituents of clay minerals: SiO_2, Al_2O_3 (but with a higher SiO_2/Al_2O_3 ratio than have the other shale units, indicating a higher proportion of quartz/clay), FeO, K_2O, and TiO_2. The average concentration of magnesium in the Blocher Shale is higher than in the other shale units, indicating the presence of dolomitic limestone or dolomite, which agrees with findings from mineralogic studies (Harvey et al., 1980).

A survey of the tables of the mean concentrations of the elements indicates that organic-rich shales are enriched in the following metals (or other elements): U, Mo, Zn, As, Se, Sb, S (pyritic S), V, Ni, Cu, Co, and probably Pb. (We are not confident of the lead results.) Vanadium, nickel and copper differ from the other elements in that they have their highest mean concentrations in the Blocher Shale rather than in the Grassy Creek. To illustrate these enrichments, figures 10 to 12 are diagrams of uranium, molybdenum, and nickel, respectively, versus organic carbon content in the New Albany Group shale samples, distinguished by stratigraphic unit. The figures show correlation, but there is much scatter to the data in each diagram, without relation to the four stratigraphic units; this will be discussed in later sections on factors affecting accumulation of the elements. Of all the elements, molybdenum shows the greatest relative enrichment, with concentrations to 180 ppm in organic-rich shale compared to concentrations of <3 ppm in shales low in organic matter. Turekian and Wedepohl (1961) also reported the molybdenum content of shale, in general as a rock type, averages 2.6 ppm.

More information on the relationship between organic content and the trace element concentrations that reflect the presence of the organic material in the black shales is obtained from correlation analyses.

Correlation Analyses

Correlation coefficients between chemical constituents in the samples of Blocher Shale, Sweetland Creek-Selmier Shale, Grassy Creek Shale and undifferentiated Grassy Creek-Sweetland Creek Shale, and Hannibal-Saverton Shale are given in tables 12, 13, 14 and 15, and for the Hardin County core in table 16. Elements in each shale unit correlate in groups. From these groups, the following principal fractions, similar to those outlined for black shales by Vine and Tourtelot (1970), can be identified:

- a detrital and clay minerals fraction,
- a carbonate fraction,

- an organic or black shale fraction,
- a sulfide fraction, principally pyrite,
- of less importance, a nonsulfidic sedimentary component (for example, resulting in sedimentation of apatite or uptake by the clay minerals of boron from seawater).

Some elements fit neatly into one fraction or another; some show by their correlations that they are associated significantly with more than one fraction. A few elements, however, do not correlate well with any others or are inconsistent from one shale unit to another, and thus can perhaps be relegated to the nonsulfidic sedimentary component.

Detrital or clay minerals fraction. Detrital clay minerals and quartz constitute most of the shale sample by weight. They are made up principally of aluminosilicates and silica. If clay minerals predominate, silicon and aluminum concentrations should correlate positively, and they did so in the Sweetland Creek-Selmier ($r = .67$) and Blocher ($r. = .66$) Shales. They did not correlate in the Grassy Creek Shale, which is the unit with the largest quartz content (Harvey et al., 1980).

The Hannibal-Saverton Shale was unique in that the elements in the clay minerals correlated (table 15) in two distinct groups: the potassium-aluminum minerals and the sodium-silicon minerals. As well as correlating mutually, Ga, Rb, Cs, Sc, Be, F, FeO, and Co correlated highly with potassium and aluminum. High mutual correlations were also obtained for Na_2O, SiO_2, TiO_2, Zr, Hf, Ta, Th, Ba, La, and Ce. Elements in the potassium-aluminum group did not correlate with those in the sodium-silicon group, with the exception of thorium with rubidium and cesium ($r = .6$).

In the other shale units, correlation analyses suggested for the detrital fraction only potassium aluminosilicates, with titanium as a minor component, perhaps as rutile deposited along with the clay minerals. The trace elements that consistently correlated with this fraction were gallium (which substitutes for aluminum); rubidium and cesium (which substitute for potassium); scandium (which always correlated best with rubidium, $r = .91$ to $.95$); Ta, Hf, and Zr (which correlated better with TiO_2 than with Al_2O_3); La, Th, and Ce; and, less consistently, Cr (not clearly in Hannibal-Saverton Shale), Ba, F, Be, Fe, and Co. The associations of the latter six elements will be discussed separately.

Carbonate fraction. In the formation of the shales there is a chemically precipitated fraction, principally calcium carbonate [$r(CaO, CO_2) = .83$ to $.98$] as calcite. Magnesium correlated just as well with carbonate, $r(MgO, CO_2) = .93$, in the Sweetland Creek-Selmier Shale, and to the extent of $r(MgO, CO_2) = .56$ in the Hannibal-Saverton Shale. The highest concentration of dolomite in these shale units is in the Blocher (Harvey et al., 1980), where $r(Mg, CO_2) = .49$; this is significant at the 95% confidence level. Magnesium is also a significant constituent of clay minerals, such as chlorite, however, and this occurrence obscures its correlations relating to carbonate. In the Grassy Creek Shale, magnesium correlated best with potassium [$r(MgO, K_2O) = .5$] and aluminum [$r(MgO, Al_2O_3) = .5$], suggesting that a magnesium-bearing clay mineral is common in this shale unit.

TABLE 7. Summary statistics for concentrations of elements in samples of Blocher Shale.

Analyte	Unit	No. values	No. <'s	Geometric mean	Arithmetic mean	Standard deviation	Maximum	Minimum
SiO_2	%	24	0	46.6	47.0	6.2	56.29	33.61
Al_2O_3	%	24	0	9.2	9.5	2.3	15.93	7.04
FeO*	%	24	0	2.8	3.0	0.9	4.85	1.79
MgO	%	24	0	3.5	3.6	0.7	5.19	1.96
CaO	%	24	0	10.1	11.7	5.6	24.22	2.22
Na_2O	%	24	0	0.49	0.50	0.12	0.74	0.15
K_2O	%	24	0	3.2	3.3	0.6	4.70	2.27
TiO_2	%	24	0	0.42	0.43	0.13	0.77	0.27
P_2O_5	%	23	1	0.09	0.11	0.06	0.25	0.02
S	%	24	0	1.8	1.9	0.6	3.70	1.02
Cl	%	24	0	0.02	0.02	0.01	0.05	0.01
CO_2	%	24	0	10.7	11.7	4.6	20.89	3.56
Org. C	%	24	0	5.1	5.3	1.5	8.97	3.33
F	%	22	0	0.10	0.10	0.03	0.19	0.076
H_2O+	%	24	0	1.3	1.8	1.2	4.04	0.12
H_2O-	%	24	0	0.32	0.35	0.15	0.70	0.11
Pyr. S	%	13	0	1.7	1.8	0.5	2.53	1.03
Sulf. S	%	10	0	0.008	0.02	0.02	0.04	0.001
SA-CO_2	m^2/g	11	0	11.5	12.2	4.9	24.4	7.
SA-N_2	m^2/g	11	0	1.4	1.6	1.2	4.7	0.8
Be	ppm	23	0	2.1	2.3	0.9	4.0	0.93
B	ppm	21	0	120.	130.	54.	280.	46.
Sc	ppm	24	0	13.	13.	3.	20.	9.3
V	ppm	23	0	260.	280.	90.	490.	140.
Cr	ppm	24	0	66.	67.	12.	93.	46.
Mn	ppm	24	0	340.	360.	170.	1100.	210.
Co	ppm	24	0	13.	13.	4.	21.	8.1
Ni	ppm	24	0	100.	110.	40.	230.	49.
Cu	ppm	23	0	130.	130.	42.	230.	53.
Zn	ppm	23	1	140.	160.	91.	360.	31.
Ga	ppm	24	0	13.	14.	4.	22.	8.7
Ge	ppm	15	8	2.0	2.2	1.4	6.7	0.6
As	ppm	24	0	14.	15.	4.	22.	7.8
Se	ppm	12	12	5.	6.	2.	8.	2.
Br	ppm	9	15	3.	4.	2.	7.	2.
Rb	ppm	24	0	100.	110.	29.	180.	74.
Sr	ppm	24	0	140.	150.	40.	240.	86.
Zr	ppm	23	0	99.	103.	32.	190.	54.
Mo	ppm	24	0	38.	41.	16.	87.	15.
Ag	ppm	9	0	0.4	0.4	0.2	0.78	0.20
Sn	ppm	21	2	5.4	5.5	1.5	8.4	4.0
Sb	ppm	24	0	3.0	3.3	1.6	7.4	1.0
Cs	ppm	24	0	5.3	5.4	1.5	8.3	4.0
Ba	ppm	24	0	310.	320.	70.	480.	230.
La	ppm	24	0	30.	30.	4.	41.	25.
Ce	ppm	24	0	49.	50.	8.	70.	35.
Sm	ppm	24	0	6.2	6.3	1.0	8.1	4.6
Eu	ppm	24	0	1.3	1.3	0.2	1.9	1.0
Tb	ppm	24	0	0.8	0.8	0.2	1.3	0.6
Dy	ppm	24	0	4.7	4.8	1.0	7.0	3.5
Yb	ppm	24	0	2.0	2.1	0.4	3.1	1.5
Lu	ppm	24	0	0.4	0.4	0.1	0.6	0.2
Hf	ppm	24	0	2.6	2.7	0.8	4.9	1.8
Ta	ppm	24	0	0.6	0.7	0.1	1.1	0.5
Pb	ppm	16	0	24.	28.0	15.0	62.	9.8
Th	ppm	24	0	6.6	6.8	1.7	11.	4.4
U	ppm	24	0	12.	12.	4.5	25.	7.

* Total iron.

TABLE 8. Summary statistics for concentrations of elements in samples of Selmier and Sweetland Creek Shales.

Analyte	Unit	No. values	No. <'s	Geometric mean	Arithmetic mean	Standard deviation	Maximum	Minimum
SiO_2	%	79	0	54.0	54.7	7.4	63.22	17.88
Al_2O_3	%	79	0	14.0	14.3	2.7	18.61	4.19
FeO*	%	79	0	4.5	4.6	0.9	6.73	2.38
MgO	%	79	0	2.4	2.8	1.9	10.75	1.05
CaO	%	79	0	2.1	3.3	4.2	23.21	0.29
Na_2O	%	79	0	0.54	0.60	0.24	0.98	0.13
K_2O	%	79	0	4.4	4.5	0.8	5.98	1.44
TiO_2	%	79	0	0.70	0.72	0.14	0.95	0.22
P_2O_5	%	76	3	0.05	0.07	0.05	0.30	0.01
S	%	79	0	1.5	1.7	0.7	4.19	0.10
Cl	%	79	0	0.02	0.02	0.02	0.10	0.01
CO_2	%	79	0	2.8	4.6	5.7	32.66	0.37
Org. C	%	79	0	3.2	4.1	2.3	11.95	0.06
F	%	78	0	0.09	0.09	0.02	0.14	0.047
H_2O+	%	79	0	2.9	3.2	1.3	7.88	0.91
H_2O-	%	79	0	0.48	0.53	0.25	1.38	0.17
Pyr. S	%	49	0	1.4	1.6	0.8	3.54	0.64
Sulf. S	%	36	5	0.01	0.02	0.02	0.09	0.001
SA-CO_2	m^2/g	45	0	16.2	18.	7.2	31.3	3.3
SA-N_2	m^2/g	45	0	5.5	9.5	7.9	21.6	0.9
Be	ppm	76	3	3.3	3.5	0.9	6.1	0.26
B	ppm	75	0	160.	170.	60.	320.	38.
Sc	ppm	79	0	18.	18.	4.	29.	5.7
V	ppm	79	0	190.	200.	90.	560.	40.
Cr	ppm	79	0	82.	84.	15.	120.	28.
Mn	ppm	79	0	310.	340.	170.	1300.	160.
Co	ppm	79	0	17.	17.	5.	27.	4.3
Ni	ppm	79	0	68.	77.	39.	290.	14.
Cu	ppm	79	0	66.	78.	37.	190.	3.8
Zn	ppm	79	0	120.	150.	86.	410.	12.
Ga	ppm	79	0	20.	20.	4.	30.	6.7
Ge	ppm	62	17	2.4	2.6	1.1	6.7	0.7
As	ppm	79	0	17.	19.	8.	45.	4.5
Se	ppm	19	60	4.	4.	2.	7.	1.
Br	ppm	20	59	3.	3.	1.	5.0	2.
Rb	ppm	79	0	150.	160.	40.	250.	53.
Sr	ppm	79	0	100.	110.	38.	260.	67.
Zr	ppm	79	0	160.	170.	40.	260.	70.
Mo	ppm	75	4	21.	37.	36.	210.	1.0
Ag	ppm	18	7	0.2	0.2	0.1	0.51	0.07
Sn	ppm	78	1	6.7	7.1	2.3	15.	1.1
Sb	ppm	79	0	2.0	2.5	1.7	11.	0.2
Cs	ppm	79	0	7.3	7.5	1.4	10.	2.4
Ba	ppm	79	0	460.	470.	90.	740.	150.
La	ppm	79	0	38.	39.	6.	55.	18.
Ce	ppm	79	0	68.	69.	10.	81.	29.
Sm	ppm	79	0	6.8	6.9	1.2	10.	3.0
Eu	ppm	79	0	1.4	1.4	0.2	1.9	0.5
Tb	ppm	79	0	0.9	0.9	0.2	1.6	0.3
Dy	ppm	79	0	5.0	5.1	0.8	6.8	1.9
Yb	ppm	79	0	2.3	2.4	0.4	3.3	0.9
Lu	ppm	79	0	0.4	0.4	0.1	0.7	0.2
Hf	ppm	79	0	4.3	4.4	1.2	9.1	1.5
Ta	ppm	79	0	1.0	1.0	0.2	1.5	0.4
Pb	ppm	65	1	33.	39.	30.	220.	4.3
Th	ppm	79	0	10.	10.	2.	15.	3.8
U	ppm	72	7	12.	15.	9.	46.	3.

* Total iron.

TABLE 9. Summary statistics for concentrations of elements in samples of Grassy Creek and undifferentiated Grassy Creek-Sweetland Creek Shales.

Analyte	Unit	No. values	No. <'s	Geometric mean	Arithmetic mean	Standard deviation	Maximum	Minimum
SiO_2	%	185	0	57.6	57.7	3.9	69.53	48.02
Al_2O_3	%	185	0	13.7	13.8	2.0	18.62	9.65
FeO*	%	185	0	5.2	5.3	1.1	10.71	3.05
MgO	%	185	0	1.5	1.6	0.5	3.05	0.45
CaO	%	185	0	1.1	1.3	0.9	7.30	0.10
Na_2O	%	185	0	0.54	0.57	0.18	0.92	0.21
K_2O	%	185	0	4.5	4.5	0.7	7.12	2.75
TiO_2	%	185	0	0.71	0.71	0.09	0.91	0.45
P_2O_5	%	177	8	0.07	0.11	0.34	4.25	0.01
S	%	185	0	2.3	2.5	1.1	6.97	0.73
Cl	%	185	0	0.02	0.03	0.02	0.12	0.01
CO_2	%	183	2	1.2	1.6	1.0	6.30	0.11
Org. C	%	185	0	6.1	6.5	2.2	15.55	1.64
F	%	180	0	0.09	0.09	0.03	0.37	0.050
H_2O+	%	182	0	2.1	2.7	1.4	7.21	0.01
H_2O-	%	185	0	0.55	0.60	0.27	1.48	0.19
Pyr. S	%	74	0	2.2	2.5	1.4	6.64	0.64
Sulf. S	%	55	13	0.02	0.07	0.15	0.77	0.001
SA-CO_2	m^2/g	69	0	20.3	21.9	8.9	53.0	9.4
SA-N_2	m^2/g	69	0	3.5	5.4	5.5	23.1	1.0
Be	ppm	184	0	3.8	3.9	0.9	6.5	2.0
B	ppm	160	0	150.	160.	40.	250.	64.
Sc	ppm	185	0	17.	17.	3.	26.	11.
V	ppm	184	0	210.	220.	100.	650.	110.
Cr	ppm	185	0	82.	83.	15.	150.	52.
Mn	ppm	185	0	290.	300.	110.	820.	110.
Co	ppm	185	0	23.	25.	7.	59.	11.
Ni	ppm	185	0	84.	87.	26.	290.	33.
Cu	ppm	184	0	79.	83.	28.	200.	29.
Zn	ppm	185	0	150.	200.	300.	3600.	30.
Ga	ppm	185	0	19.	20.	3.	27.	11.
Ge	ppm	146	38	2.3	2.4	0.8	6.4	0.8
As	ppm	185	0	31.	34.	14.	92.	9.6
Se	ppm	38	147	7.	10.	7.	25.	1.
Br	ppm	70	115	4.	4.	2.	9.4	1.
Rb	ppm	185	0	150.	150.	30.	250.	95.
Sr	ppm	185	0	92.	100.	62.	730.	55.
Zr	ppm	184	0	160.	160.	30.	250.	110.
Mo	ppm	185	0	60.	71.	36.	180.	4.
Ag	ppm	55	42	0.2	0.4	0.6	3.7	0.04
Sn	ppm	180	4	6.6	7.1	2.9	21.	2.4
Sb	ppm	185	0	3.9	4.4	2.1	14.	0.9
Cs	ppm	185	0	7.1	7.3	1.4	12.	2.8
Ba	ppm	185	0	480.	520.	470.	6800.	330.
La	ppm	185	0	38.	39.	4.	50.	28.
Ce	ppm	185	0	67.	67.	10.	160.	48.
Sm	ppm	185	0	6.9	7.0	1.4	22.	5.0
Eu	ppm	185	0	1.4	1.4	0.3	5.	1.1
Tb	ppm	185	0	0.9	0.9	0.3	3.6	0.6
Dy	ppm	185	0	5.2	5.3	1.0	17.	4.0
Yb	ppm	185	0	2.4	2.4	0.3	5.3	1.8
Lu	ppm	185	0	0.5	0.5	0.1	0.9	0.3
Hf	ppm	185	0	4.0	4.0	0.8	7.3	2.6
Ta	ppm	185	0	1.0	1.0	0.2	1.6	0.7
Pb	ppm	155	0	37.	43.	26.	230.	8.6
Th	ppm	185	0	9.8	9.9	1.4	14.	6.9
U	ppm	184	1	26.	29.	13.	75.	5.

* Total iron.

TABLE 10. Summary statistics for concentrations of elements in samples of Hannibal and Saverton Shales.

Analyte	Unit	No. values	No. <'s	Geometric mean	Arithmetic mean	Standard deviation	Maximum	Minimum
SiO_2	%	60	0	55.8	56.3	7.2	74.03	35.67
Al_2O_3	%	60	0	14.0	14.2	2.3	17.20	6.81
FeO*	%	60	0	4.3	4.4	0.8	6.14	1.86
MgO	%	60	0	2.7	2.9	1.1	5.49	1.03
CaO	%	60	0	1.6	3.3	3.9	20.99	0.01
Na_2O	%	60	0	0.44	0.52	0.32	1.37	0.24
K_2O	%	60	0	5.5	5.6	1.1	7.21	2.80
TiO_2	%	60	0	0.81	0.82	0.12	1.07	0.44
P_2O_5	%	48	12	0.04	0.05	0.06	0.33	0.01
S	%	60	0	0.60	0.74	0.49	2.43	0.09
Cl	%	60	0	0.03	0.04	0.04	0.14	0.01
CO_2	%	58	2	2.3	4.4	3.8	18.58	0.02
Org. C	%	60	0	0.98	1.3	1.2	6.14	0.15
F	%	59	0	0.08	0.08	0.02	0.12	0.038
H_2O+	%	60	0	3.5	3.9	1.5	7.48	0.40
H_2O-	%	60	0	0.83	0.98	0.79	4.32	0.26
Pyr. S	%	50	0	0.59	0.70	0.40	1.70	0.09
Sulf. S	%	22	14	0.02	0.02	0.02	0.08	0.001
SA-CO_2	m^2/g	47	0	28.1	29.8	8.6	45.4	10.1
SA-N_2	m^2/g	47	0	26.7	28.7	9.1	42.1	8.0
Be	ppm	60	0	3.4	3.5	0.7	4.6	1.4
B	ppm	58	0	140.	140.	30.	220.	72.
Sc	ppm	60	0	18.	18.	3.	25.	10.
V	ppm	60	0	120.	150.	200.	1600.	66.
Cr	ppm	60	0	87.	88.	16.	180.	53.
Mn	ppm	60	0	370.	430.	270.	1700.	120.
Co	ppm	60	0	15.	16.	4.	30.	5.3
Ni	ppm	60	0	40.	45.	32.	260.	21.
Cu	ppm	60	0	22.	25.	14.	86.	11.
Zn	ppm	60	0	76.	120.	190.	1100.	25.
Ga	ppm	60	0	20.	21.	4.	26.	8.2
Ge	ppm	56	4	2.3	2.4	0.9	5.7	0.6
As	ppm	60	0	11.	13.	7.	31.	2.3
Se	ppm	4	56	3.	4.	5.	12.	1.
Br	ppm	17	43	6.	6.	3.	11.	1.
Rb	ppm	60	0	180.	190.	40.	270.	100.
Sr	ppm	60	0	85.	89.	32.	210.	61.
Zr	ppm	60	0	190.	200.	70.	440.	98.
Mo	ppm	32	28	4.5	12.	18.	73.	0.3
Sn	ppm	58	2	6.4	6.9	3.0	17.	1.7
Sb	ppm	60	0	0.7	0.9	1.0	6.9	0.3
Cs	ppm	60	0	9.6	9.9	2.3	14.	4.9
Ba	ppm	60	0	410.	420.	50.	580.	280.
La	ppm	60	0	38.	38.	4.	48.	31.
Ce	ppm	60	0	73.	74.	9.	98.	54.
Sm	ppm	60	0	5.8	5.9	1.3	14.	4.3
Eu	ppm	60	0	1.1	1.1	0.3	3.0	0.8
Tb	ppm	60	0	0.7	0.8	0.2	1.8	0.4
Dy	ppm	60	0	4.2	4.3	1.1	9.8	3.1
Yb	ppm	60	0	2.2	2.2	0.4	3.8	1.4
Lu	ppm	60	0	0.4	0.4	0.1	0.7	0.3
Hf	ppm	60	0	5.1	5.4	1.8	11.	3.4
Ta	ppm	60	0	1.2	1.3	0.2	2.0	0.5
Pb	ppm	52	5	20.	27.	35.	250.	7.0
Th	ppm	60	0	12.	12.	2.	15.	6.8
U	ppm	18	42	6.9	9.1	7.9	35.	2.6

* Total iron.

TABLE 11. Summary statistics for concentrations of elements in 25 samples of the Hardin County, Illinois core (11IL). (Sample S00378 was not included.)

Analyte	Unit	No. values	No. <'s	Geometric mean	Arithmetic mean	Standard deviation	Maximum	Minimum
SiO_2	%	25	0	55.2	55.6	5.8	64.07	39.58
Al_2O_3	%	25	0	13.8	14.0	2.3	18.56	10.15
FeO*	%	25	0	4.7	4.8	1.0	8.08	3.25
MgO	%	25	0	1.7	2.0	1.1	4.77	0.26
CaO	%	25	0	2.5	3.4	2.7	10.51	0.16
Na_2O	%	25	0	3.1	3.3	1.3	6.43	0.97
K_2O	%	25	0	5.4	5.5	1.2	8.11	3.98
TiO_2	%	25	0	0.68	0.70	0.12	0.91	0.44
P_2O_5	%	25	0	0.05	0.07	0.06	0.32	0.01
S	%	25	0	1.5	1.7	1.0	5.00	0.62
Cl	%	25	0	0.01	0.01	0.00	0.02	0.01
CO_2	%	25	0	5.1	6.1	3.4	15.76	0.27
Org. C	%	25	0	2.0	2.7	1.9	6.50	0.43
F	%	24	0	0.13	0.24	0.27	1.17	0.014
H_2O+	%	25	0	1.4	1.6	0.9	3.80	0.41
H_2O-	%	25	0	0.11	0.13	0.08	0.36	0.04
Pyr. S	%	25	0	1.4	1.6	0.9	4.57	0.55
Sulf. S	%	16	9	0.02	0.02	0.02	0.09	0.007
$SA-CO_2$	m^2/g	21	0	7.5	8.4	3.9	18.4	3.2
$SA-N_2$	m^2/g	21	0	2.3	2.8	1.8	7.6	0.8
Be	ppm	25	0	12.	23.	32.	120.	2.8
B	ppm	25	0	22.	44.	58.	190.	3.9
Sc	ppm	25	0	19.	19.	5.	33.	9.6
V	ppm	25	0	170.	180.	50.	330.	99.
Cr	ppm	25	0	88.	89.	13.	110.	56.
Mn	ppm	25	0	280.	310.	140.	660.	44.
Co	ppm	25	0	25.	27.	13.	59.	14.
Ni	ppm	25	0	77.	86.	39.	180.	22.
Cu	ppm	25	0	75.	79.	24.	130.	36.
Zn	ppm	25	0	120.	150.	150.	840.	29.
Ga	ppm	24	1	20.	20.	4.	27.	12.
Ge	ppm	25	0	2.2	2.2	0.5	3.3	1.4
As	ppm	25	0	51.	55.	21.	110.	26.
Se	ppm	5	20	6.	6.	2.	10.	5.
Rb	ppm	25	0	170.	170.	40.	280.	97.
Sr	ppm	25	0	290.	360.	310.	1600.	120.
Zr	ppm	25	0	180.	190.	70.	390.	90.
Mo	ppm	17	8	42.	59.	45.	150.	6.7
Ag	ppm	12	13	0.2	0.2	0.1	0.56	0.15
Sn	ppm	24	1	7.2	7.5	2.1	13.	3.6
Sb	ppm	25	0	4.7	5.7	3.7	14.	1.8
Cs	ppm	24	1	1.4	1.9	1.5	6.3	0.3
Ba	ppm	25	0	300.	340.	200.	1000.	130.
La	ppm	25	0	40.	41.	7.	56.	27.
Ce	ppm	25	0	72.	73.	12.	95.	47.
Sm	ppm	25	0	6.8	7.0	1.5	11.	4.1
Eu	ppm	25	0	1.4	1.4	0.3	1.9	0.9
Tb	ppm	25	0	0.9	0.9	0.3	1.5	0.3
Dy	ppm	25	0	5.7	6.0	1.8	11.	1.6
Yb	ppm	25	0	2.9	3.1	1.1	6.2	1.2
Lu	ppm	25	0	0.5	0.6	0.2	1.1	0.2
Hf	ppm	25	0	4.4	4.5	1.1	7.0	3.1
Ta	ppm	25	0	1.0	1.0	0.2	1.6	0.7
Pb	ppm	25	0	43.	48.	23.	97.	19.
Th	ppm	25	0	17.	20.	12.	62.	9.6
U	ppm	16	9	15.	19.	15.	48.	5.
W	ppm	25	0	6.2	6.4	2.1	12.	4.

* Total iron.

TABLE 12. Correlation coefficient matrix for the chemical components of 24 samples of Blocher Shale. ("Less than" values were not included in the analysis. Coefficients < ±0.1 were deleted.)

	Zn	Ga	Ge	As	Se	Br	Rb	Sr	Zr	Mo	Ag	Sn	Sb	Cs
Zn	1.00*	-.33	-.53	.11	.72*				.15	.45+	.30		.81*	-.25
Ga		1.00*	.59+	.68*	-.66+	.30	.80*	-.38	.58*	.18			-.12	.82*
Ge			1.00*	.43	-.90*	-.32	.34	-.35	.22	-.48	.26	-.16	-.30	.40
As				1.00*	-.18	-.28	.59*	-.52*	.61*	.30		-.19	.28*	.55*
Se					1.00*		-.16		.18	.64+			.74*	-.35
Br						1.00*				.15	.14	.24		
Rb							1.00*	-.43+	.57*	.16	.29	.26	.14	.94*
Sr								1.00*	-.40		.52	.18		-.39
Zr									1.00*	.15	-.40		.43+	.51+
Mo										1.00*	.27		.49+	
Ag											1.00*		.80*	.17
Sn												1.00*		.20
Sb													1.00*	
Cs														1.00*

	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	S	Cl	CO_2	Org.C	F
SiO_2	1.00*													
Al_2O_3	.66*	1.00*												
FeO	.32	.61*	1.00*											
MgO	-.41+	-.67*	-.25	1.00*										
CaO	-.92*	-.76*	-.57*	.33	1.00*									
Na_2O	.44+	.26		-.59*	-.23	1.00*								
K_2O	.74*	.92*	.60*	-.63*	-.84*	.29	1.00*							
TiO_2	.72*	.97*	.67*	-.59*	-.84*	.24	.94*	1.00*						
P_2O_5	.14	-.44+	-.42+	.38			-.26	-.37	1.00*					
S	.19	.15	.79*		-.35		.25	.24		1.00*				
Cl		.31	.33	-.25		.15	.22	.25	-.51+		1.00*			
CO_2	-.93*	-.80*	-.55*	.49+	.97*	-.36	-.88*	-.86*		-.30		1.00*		
Org.C	.42+	.29	.22		-.58*	-.26	.41+	.35	.39	.11		-.52*	1.00*	
F	.40	.36		-.15	-.36		.42	.32		-.13	.46+	-.39	.48+	1.00*
Pyr.S	.35	.21	.78*	-.13	-.43	.20	.45	.40	-.12	.95*		-.44		-.21
Sulf.S	.34		.48	.16	-.44		.32	.17	.49	.79*	-.72+	-.39	.39	-.29
$SA\text{-}CO_2$		.33	.36	.57	-.33	-.89*	.19	.36				-.27	.85*	.30
$SA\text{-}N_2$		.57	.31	.60+	-.34	-.77*	.20	.52	-.21	-.16	.20	-.29	.50	.55
H_2O+	.13	.41+	.28	-.12	-.27	-.15	.33	.43+	-.42+		-.12	-.27		
Be	.57*	.43+	.33		-.72*		.65*	.52*	.34	.27		-.66*	.73*	.41
B	.58*	.66*	.44+	-.13	-.75*		.82*	.74*		.29	.19	-.75*	.65*	.55+
Sc	.68*	.87*	.44+	-.60*	-.77*	.14	.91*	.85*	-.23		.24	-.82*	.51*	.59*
V	-.12	-.18	-.37		.16	-.30		-.22	.29	-.27		.16	.35	.44+
Cr	.71*	.75*	.34	-.55*	-.75*		.80*	.74*				-.79*	.60*	.56*
Mn	-.27	-.28	-.25	.63*	.16	-.65*	-.40	-.26	.20	-.25	-.18	.26	.30	
Co	.60*	.81*	.69*	-.53*	-.73*	.21	.87*	.84*	-.30	.40	.43+	-.77*	.38	.50+
Ni	.13	-.19	-.19	.21	-.14	-.21		-.14	.64*		-.35		.58*	.27
Cu	-.21	-.33	-.18	.49+	.12	-.57*	-.31	-.31	.36			.19	.59*	.23
Zn		-.25	-.30	.15	.15	-.27	-.22	-.30	.42		-.25	.15	.31	.22
Ga	.57*	.91*	.68*	-.64*	-.70*	.22	.91*	.92*	-.47+	.28	.38	-.74*	.26	.36
Ge	.40	.61+	.72*	-.33	-.45	.43	.45	.60+	-.27	.67*	.73*	-.49	.18	
As	.59*	.63*	.72*	-.37	-.71*	.25	.75*	.69*		.65*	.15	-.72*	.39	.28
Se		-.48	-.80*	.28	.13	-.23	-.29	-.51	.69+	-.65+	-.71*	.18	.22	
Br	.17		-.34	-.19						-.42				.37
Rb	.60*	.85*	.47+	-.67*	-.68*	.21	.88*	.82*	-.37		.40	-.74*	.39	.63*
Sr	-.78*	-.38	-.32		.79*	-.17	-.52*	-.49+	-.22	-.32		.75*	-.57*	-.54*
Zr	.65*	.72*	.35	-.33	-.67*	.18	.71*	.72*	-.16	.20		-.68*	.26	.23
Mo				-.34		.14	.20		.16	-.13	-.16		.11	
Ag	-.44	-.13		-.57	.29		.13	-.24		.17	.39	.15	.16	
Sn	-.11	.13	-.29	-.28	.26	.15			-.36	-.48+	.42	.20	-.35	.30
Sb	.15		-.19	-.19					.35		-.27		.20	.14
Cs	.49+	.85*	.58*	-.55*	-.63*		.86*	.83*	-.52*	.15	.48+	-.68*	.33	.58*
Ba	.45+	.62*	.46+	-.36	-.61*	-.14	.60*	.65*		.17		-.61*	.51*	.16
La	.58*	.82*	.57*	-.57*	-.72*	.13	.87*	.87*	-.23	.21		-.72*	.27	.13
Ce	.71*	.84*	.62*	-.57*	-.82*	.17	.89*	.88*	-.15	.32		-.84*	.39	.22
Sm	.45+	.20	.13	-.15	-.50+		.44+	.28	.41	.15	-.41+	-.48+	.49+	.26
Eu	.39	.18	.12		-.47+		.41+	.27	.37	.16	-.41+	-.42+	.49+	.26
Tb	.16		-.11		-.18	-.21	.25		.36		-.21	-.16	.43+	.39
Dy	.44+		-.12		-.37	.17	.20		.70*		-.51*	-.32	.36	.11
Yb	.48+	.18			-.49+		.40	.26	.42+	.11	-.45+	-.46+	.48+	.28
Lu	.62*	.33			-.63*		.49+	.38	.35		-.33	-.59*	.52*	.49+
Hf	.66*	.86*	.71*	-.57*	-.76*	.36	.85*	.87*	-.27	.35	.49+	-.81*	.44+	.41
Ta	.63*	.83*	.61*	-.46+	-.76*	.17	.83*	.86*	-.28	.24		-.78*	.31	.22
Pb	.18	.50+	.74*	-.35	-.33	.17	.44	.55+	-.54+	.51+	.31	-.43	.11	
Th	.67*	.93*	.65*	-.55*	-.81*	.16	.94*	.93*	-.35	.27	.31	-.84*	.46+	.49+
U	.42+	.43+	.29	-.39	-.50+	.15	.59*	.49+	.22	.15	-.16	-.51*	.48+	.11

	Ba	La	Ce	Sm	Eu	Tb	Dy	Yb	Lu	Hf	Ta	Pb	Th	U
Zn		-.29	-.11	.28	.39	.58*	.41	.44+	.37	-.17	-.18	-.28		.26
Ga	.56*	.83*	.80*	.27	.23			.18	.23	.82*	.72*	.46	.87*	.51*
Ge		.25	.35	-.30	-.46	-.42	-.34	-.46	-.27	.77*	.31	.53	.47	-.14
As	.47+	.62*	.72*	.40	.50+	.33	.35	.50+	.43+	.77*	.64*	.38	.76*	.62*
Se	.11		-.15	.58+	.67+	.76*	.75*	.80*	.78*	-.45		-.67	-.30	.48
Br					.11				-.13	-.22	-.39	-.44	-.15	.13
Rb	.54*	.68*	.73*	.40	.38	.33		.32	.46+	.81*	.75*	.34	.90*	.47+
Sr	-.33	-.34	-.45+	-.43+	-.39	-.19	-.41+	-.49+	-.65*	-.53*	-.44+	-.16	-.49+	-.25
Zr	.32	.65*	.68*	.17	.24	.34	.26	.39	.53*	.59*	.63*	.35	.72*	.42+
Mo	.13	.35	.26	.40	.56*	.60*	.41+	.58*	.32		.13	-.22	.12	.75*
Ag			.13	.29	.26	.42	.24	.14	-.34			.12		.59
Sn	-.28	-.20	-.27	-.34	-.22		-.26	-.20	-.25			-.41		-.24
Sb				.38	.46+	.67*	.47+	.50+	.45+			-.18		.42+
Cs	.54*	.70*	.72*	.27	.25	.21		.19	.34	.79*	.77*	.49	.90*	.32
Ba	1.00*	.61*	.66*	.46+	.35	.14		.27	.32	.54*	.57*	.42	.65*	.45+
La		1.00*	.91*	.45+	.45+	.29	.23	.42+	.44+	.68*	.80*	.38	.78*	.66*
Ce			1.00*	.49+	.47+	.27	.32	.48+	.54*	.76*	.86*	.53+	.86*	.62*
Sm				1.00*	.83*	.65*	.70*	.78*	.71*	.20	.39	-.11	.35	.69*
Eu					1.00*	.75*	.75*	.89*	.72*	.19	.37	-.14	.35	.76*
Tb						1.00*	.65*	.74*	.66*		.17	-.27	.24	.66*
Dy							1.00*	.83*	.70*		.25	-.34	.11	.57*
Yb								1.00*	.81*	.21	.44+	-.13	.35	.68*
Lu									1.00*	.28	.48+		.47+	.51*
Hf										1.00*	.78*	.51+	.90*	.45+
Ta											1.00*	.46	.86*	.47+
Pb												1.00*	.51+	
Th													1.00*	.50+
U														1.00*

	Pyr.S	SulfS	$SACO_2$	$SA-N_2$	H_2O+	Be	B	Sc	V	Cr	Mn	Co	Ni	Cu
Pyr.S	1.00*													
Sulf.S	.72+	1.00*												
$SA-CO_2$		.14	1.00*											
$SA-N_2$	-.16	-.24	.80*	1.00*										
H_2O+			.12	.33	1.00*									
Be	.41	.54	.27			1.00*								
B	.46	.42	.44	.25		.81*	1.00*							
Sc	.11		.48	.43	.22	.61*	.79*	1.00*						
V	-.51		.17	-.20	-.37			.16	1.00*					
Cr		.19	.55	.38		.53*	.60*	.90*	.39	1.00*				
Mn	-.45	-.28	.72+	.73*	.17		-.13	-.26		-.22	1.00*			
Co	.48				.34	.59*	.72*	.80*		.68*	-.34	1.00*		
Ni	-.19	.47	.22		-.35	.31	.15	.12	.74*	.41+			1.00*	
Cu	-.38	.21	.76*	.35	-.29		.13		.67*	.14	.50+	-.21	.64*	1.00*
Zn	-.49	.13	.18	-.39	-.45+		-.13		.78*	.28	.11	-.26	.79*	.74*
Ga	.43	.15	.22	.33	.44+	.42+	.60*	.80*	-.16	.66*	-.33	.88*	-.19	-.35
Ge	.53		.14	.14		.42	.38	.24	-.64*		-.25	.51	-.52+	-.35
As	.53	.60		-.11	.14	.52*	.50+	.62*		.66*	-.42+	.75*	.27	
Se	-.60	.27	-.20	-.77	-.43		-.20		.70*	.42	.39	-.46	.82*	.55
Br	-.45	-.57	.50	.34	-.35	-.25		.14	.29	.22	.12			
Rb	.12		.19	.16	.20	.53*	.75*	.95*	.15	.81*	-.41+	.83*		-.12
Sr	-.37	-.23	-.15	-.29		-.62*	-.64*	-.48+		-.54*		-.59*	-.28	
Zr	.49	.41	.15	.14	.13	.43+	.38	.67*		.68*	-.28	.47+	.11	-.16
Mo		.29	-.29	-.41	-.15		-.22	.22	.54*	.40	-.34	.17	.57*	.11
Ag	.15	.48		-.50	-.26	.25	.24	.18	.59		-.31		.21	.17
Sn	-.54	-.73+	-.46	-.29		-.28	-.21		.31		-.14		-.27	
Sb		.47	-.12	-.53	-.47+	.12		.19	.67*	.44+	-.35		.63*	.30
Cs	.27		.28	.36	.30	.47+	.77*	.89*		.69*	-.32	.84*	-.15	-.18
Ba	.13	.24	.90*	.79*	.29	.27	.47+	.65*		.72*		.52*	.15	.19
La	.76*	.55	.16	.14	.45+	.54*	.69*	.76*	-.17	.69*	-.31	.77*		-.37
Ce	.62+	.52	.28	.19	.32	.59*	.80*	.82*	-.12	.79*	-.30	.78*		-.19
Sm	.16	.66+		-.16		.59*	.53+	.49+	.36	.60*	-.22	.38	.59*	.15
Eu	.13	.74+	.11	-.19		.50+	.43	.46+	.50+	.58*	-.18	.34	.70*	.28
Tb		.47		-.23	-.19	.44+	.29	.41+	.68*	.53*	-.20	.21	.72*	.32
Dy	.14	.68+	-.25	-.47	-.24	.60*	.31	.21	.32	.35	-.20	.14	.67*	.11
Yb	.12	.68+		-.31		.54*	.39	.43+	.50+	.58*	-.19	.35	.75*	.24
Lu		.32		.12		.59*	.49+	.59*	.34	.69*		.37	.60*	.15
Hf	.42	.14	.24	.19	.18	.57*	.66*	.79*	-.13	.70*	-.35	.88*		-.15
Ta	.36	.13		.20	.39	.55*	.74*	.80*	-.12	.68*	-.26	.79*		-.23
Pb	.68*	.54	.43	.36	.18		.43	.28	-.41	.17	-.23	.35	-.23	
Th	.31	.17	.46	.44	.32	.59*	.82*	.93*		.82*	-.28	.86*		-.12
U	.21	.60		-.30		.52*	.26	.57*	.40	.67*	-.31	.51*	.53*	

+ Significant at the 95% confidence level, * significant at the 99% confidence level.

TABLE 13. Correlation coefficient matrix for the chemical components of 79 samples of Sweetland Creek-Selmier Shale. ("Less than" values were not included in the analysis. Coefficients < ±0.1 were deleted.)

Zn	Ga	Ge	As	Se	Br	Rb	Sr	Zr	Mo	Ag	Sn	Sb	Cs	
1.00*	.15		.49*	.65*	.40				.59*	.35		.58*	.32*	Zn
	1.00*	.16		.22		.80*	-.31*	.34*		.19	.26+	.14	.77*	Ga
		1.00*	-.14	-.43				.23	-.12	.33	.13		.16	Ge
			1.00*	.88*	.20	-.12			.81*			.75*		As
				1.00*			.12	.16	.77*	.64	-.30	.78*	.15	Se
					1.00*	-.25	.59*	.12	.34		-.12	.40		Br
						1.00*	-.45*	.32*			.18		.78*	Rb
							1.00*	-.26+	.18			.21	-.26+	Sr
								1.00*		-.11			.23+	Zr
									1.00*	.14	-.16	.85*		Mo
										1.00*	-.27	.33	.36	Ag
											1.00*		.34*	Sn
												1.00*	.16	Sb
													1.00*	Cs

	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	S	Cl	CO_2	Org.C	F
SiO_2	1.00*													
Al_2O_3	.67*	1.00*												
FeO		.34*	1.00*											
MgO	-.89*	-.70*	-.26+	1.00*										
CaO	-.88*	-.83*	-.31*	.90*	1.00*									
Na_2O	.40*	.12	-.14	-.38*	-.29*	1.00*								
K_2O	.58*	.86*	.26+	-.60*	-.77*	-.12	1.00*							
TiO_2	.69*	.82*	.19	-.68*	-.79*		.80*	1.00*						
P_2O_5	-.12			.14	.11				1.00*					
S	.11		.46*	-.35*	-.32*	.16				1.00*				
Cl						.45*					1.00*			
CO_2	-.89*	-.82*	-.29*	.93*	.98*	-.27+	-.75*	-.79*	.13	-.32*		1.00*		
Org.C	.22		.22	-.47*	-.40*	.41*				.75*		-.41*	1.00*	
F	.26+	.43*	.13	-.33*	-.37*		.47*	.27+		.33*	.23+	-.37*	.17	1.00*
H_2O+	.27+	.34*		-.14	-.27+	-.22	.40*	.46*	-.14	-.32*		-.27+	-.35*	
Pyr.S	.12		.50*	-.36+	-.33+	.15			-.11	.98*		-.33+	.72*	.36+
Sulf.S	-.17	-.20	.24			-.17			-.13	.59*	-.32		.25	
$SA-CO_2$	.19	.50*	.44*	-.35+	-.45*	-.53*	.60*	.45*	-.16	.34+	-.47*	-.47*	.14	.30+
$SA-N_2$		.39*	.17		-.13	-.84*	.53*	.37+	-.13	-.32+	-.55*	-.15	-.58*	
Be	.31*	.51*	.20	-.44*	-.56*		.51*	.38*		.21		-.54*	.34*	.22
B	.49*	.31*		-.49*	-.47*	.68*	.22	.33*		.19	.27+	-.43*	.39*	.24+
Sc	.59*	.84*	.19	-.61*	-.73*		.87*	.74*				-.72*		.36*
V	.25+		.31*	-.39*	-.28+	.47*				.45*	.17	-.28+	.54*	.16
Cr	.65*	.65*		-.72*	-.71*	.47*	.62*	.62*		.11	.21	-.70*	.34*	.42*
Mn	-.76*	-.54*		.80*	.74*	-.31*	-.54*	-.51*		-.34*		.78*	-.45*	-.41*
Co	.38*	.60*	.61*	-.56*	-.64*		.54*	.44*	-.13	.55*	.11	-.64*	.45*	.42*
Ni	.21		.27+	-.42*	-.30*	.39*				.69*		-.30*	.77*	
Cu	.22			-.39*	-.27+	.63*				.44*	.18	-.28+	.76*	.18
Zn	.33*	.17	.24+	-.46*	-.39*	.31*	.14	.16		.46*	.11	-.39*	.49*	.17
Ga	.55*	.91*	.38*	-.61*	-.75*		.84*	.76*				-.74*		.36*
Ge	.35*	.18		-.24	-.19	.20	.11	.29+	.19	-.18	.33*	-.22	-.16	.13
As	.15		.50*	-.32*	-.28+					.74*		-.27+	.59*	.12
Se	.21	.23	.78*	-.79*	-.78*	-.21			.22	.69*	-.16	-.78*	.43	
Br	-.36	-.17		-.11		.25				.28	-.26		.66*	-.42
Rb	.52*	.80*	.24+	-.53*	-.66*	-.17	.88*	.71*				-.66*		.28+
Sr	-.30*	-.35*		.12	.36*	.28+	-.47*	-.31*				.35*	.15	-.21
Zr	.46*	.37*		-.33*	-.43*		.39*	.72*		-.18	-.12	-.42*	-.16	
Mo	.21		.39*	-.39*	-.32*	.22			-.11	.72*		-.32*	.68*	.13
Ag	.14			-.23	-.16		.14		.24	.14		-.13	.26	.31
Sn	.31*	.33*		-.28+	-.28+	.36*	.26+	.25+	-.14		.57*	-.28+		.19
Sb	.24+	.12	.41*	-.46*	-.37*	.40*			-.11	.70*		-.37*	.73*	.13
Cs	.64*	.77*	.17	-.68*	-.75*	.21	.77*	.65*			.18	-.73*	.18	.46*
Ba	.56*	.82*	.39*	-.58*	-.70*		.76*	.77*				-.69*		.23+
La	.61*	.73*	.20	-.64*	-.73*	.23+	.71*	.81*				-.72*	.16	.33*
Ce	.71*	.78*	.25+	-.73*	-.81*	.33*	.71*	.84*			.14	-.79*	.21	.35*
Sm	.42*	.47*	.21	-.50*	-.55*	.41*	.40*	.52*	.37*	.19	.18	-.52*	.35*	.26+
Eu	.40*	.38*	.17	-.52*	-.54*	.43*	.37*	.41*	.27+	.34*	.12	-.52*	.55*	.29*
Tb	.20	.28+		-.30*	-.35*		.37*	.43*	.22			-.33*	.31*	
Dy	.45*	.28+		-.52*	-.52*	.53*	.24+	.47*	.19	.25+		-.50*	.54*	.13
Yb	.46*	.38*		-.51*	-.55*	.36*	.43*	.54*		.14		-.53*	.42*	
Lu	.51*	.33*		-.55*	-.53*	.29*	.31*	.51*		.20		-.53*	.38*	
Hf	.38*	.35*	-.15	-.23+	-.34*	-.12	.45*	.62*		-.37*		-.32*	-.28+	
Ta	.59*	.66*		-.57*	-.66*	.22	.65*	.83*		-.13		-.65*		.13
Pb	.18		.28+	-.23	-.23					.36*		-.22	.29+	.15
Th	.60*	.74*		-.57*	-.68*	.12	.74*	.86*		-.17		-.66*		.28+
U	.17		.38*	-.38*	-.29+	.29+			-.12	.66*		-.30*	.67*	.15

	Ba	La	Ce	Sm	Eu	Tb	Dy	Yb	Lu	Hf	Ta	Pb	Th	U
Zn	.15	.32*	.35*	.37*	.50*	.21	.46*	.39*	.39*		.15	.14	.13	.57*
Ga	.83*	.74*	.75*	.47*	.39*	.36*	.28+	.39*	.32*	.39*	.68*		.72*	
Ge	.16	.26+	.35*	.26+	.14		.22		.21	.24	.23		.31+	-.13
As		.15	.13	.29*	.39*	.15	.23+		.25+	-.18		.41*	-.11	.86*
Se	.35	.38	.39	.59*	.57*	.31	.11	.12	.51+	-.40	-.16	.48	-.18	.86*
Br			.17	.37	.42	.30	.43	.37	.18		-.15	-.26	-.11	.18
Rb	.80*	.61*	.62*	.27+	.26+	.42*	.12	.43*	.30*	.55*	.66*		.77*	-.16
Sr	-.23+	-.25+	-.17				.12			-.30*	-.19	-.14	-.25+	
Zr	.39*	.56*	.55*	.36*	.23+	.37*	.37*	.39*	.48*	.77*	.63*		.59*	-.13
Mo		.19	.21	.27+	.43*	.16	.34*	.20	.36*	-.23+		.32+		.92*
Ag		.13	.25	.30	.32	.29	.33	.35	.13				.13	.13
Sn	.19	.31*	.30*	.11	.11			.17	.11		.25+		.26+	
Sb		.21	.24+	.37*	.51*	.20	.39*	.29*	.42*	-.23+		.35*		.84*
Cs	.73*	.70*	.76*	.45*	.49*	.45*	.36*	.54*	.37*	.43*	.69*		.79*	
Ba	1.00*	.68*	.73*	.45*	.37*	.42*	.29*	.43*	.38*	.47*	.73*		.77*	
La		1.00*	.87*	.67*	.64*	.49*	.55*	.62*	.54*	.49*	.76*	.15	.79*	.17
Ce			1.00*	.71*	.63*	.50*	.64*	.61*	.50*	.49*	.78*		.85*	.17
Sm				1.00*	.81*	.51*	.70*	.59*	.44*	.24+	.50*	.17	.52*	.29+
Eu					1.00*	.64*	.79*	.71*	.54*	.16	.47*	.29+	.48*	.48*
Tb						1.00*	.63*	.66*	.48*	.47*	.54*		.55*	.12
Dy							1.00*	.73*	.56*	.24+	.53*	.15	.47*	.34*
Yb								1.00*	.67*	.46*	.62*	.14	.64*	.12
Lu									1.00*	.34*	.51*	.29+	.46*	.29+
Hf										1.00*	.69*		.73*	-.32*
Ta											1.00*		.87*	
Pb												1.00*		.39*
Th													1.00*	-.13
U														1.00*

	H_2O+	Pyr.S	SulfS	SACO$_2$	SA-N$_2$	Be	B	Sc	V	Cr	Mn	Co	Ni	Cu
H_2O+	1.00*													
Pyr.S	-.33+	1.00*												
Sulf.S		.59*	1.00*											
SA-CO$_2$	.17	.36+	.51*	1.00*										
SA-N$_2$	.50*	-.24	.14	.64*	1.00*									
Be		.16		.42*		1.00*								
B	-.18	.13	-.17	-.16	-.56*	.35*	1.00*							
Sc	.32*		-.28	.44*	.36+	.47*	.38*	1.00*						
V	-.27+	.54*		.12	-.51*	.16	.35*		1.00*					
Cr	.14	.13	-.19	.16	-.20	.39*	.62*	.69*	.40*	1.00*				
Mn	-.13	-.41*		-.35+		-.25+	-.43*	-.52*	-.28+	-.66*	1.00*			
Co		.57*	.21	.64*	.19	.48*		.46*	.28+	.34*	-.43*	1.00*		
Ni	-.37*	.67*	.20	.17	-.50*	.13	.37*		.79*	.35*	-.38*	.31*	1.00*	
Cu	-.35*	.45*		-.20	-.75*	.25+	.59*		.59*	.50*	-.42*		.68*	1.00*
Zn		.47*	.18	.18	-.26	.15	.36*	.18	.56*	.39*	-.42*	.27+	.67*	.45*
Ga	.25+		-.19	.54*	.38*	.56*	.27+	.82*	.11	.64*	-.47*	.56*		
Ge	.25+	-.14		-.20		-.12	.16	.13		.30+	-.14		-.11	
As	-.21	.74*	.44*	.39*	-.23	.20			.56*		-.21	.54*	.69*	.27+
Se		.77*	.25	.76+			-.42		.69*	.13	-.31	.77*	.64*	
Br	-.36	.27	.58	.65+	-.41	.37	.29		.33	.18	-.35		.58*	.67*
Rb	.39*		-.20	.57*	.61*	.45*	.19	.93*		.57*	-.43*	.49*	-.14	-.11
Sr	-.23+			-.39*	-.58*	-.26+	.19	-.34*	.29*		.16	-.37*	.30*	.34*
Zr	.36*			.26	.26		.13	.33*		.33*	-.28+			-.12
Mo	-.25+	.71*	.33+	.42*	-.26	.12	.22		.71*	.16	-.34*	.48*	.82*	.36*
Ag		.34	.45	.23	-.49	-.18	.28	.23	.28	.45	-.32		.29	.74*
Sn	.17	-.12	-.38+	-.29	-.33+	.14	.30*	.29*	.12	.41*	-.17			.24+
Sb	-.29*	.71*	.27	.32+	-.42*	.19	.33*		.76*	.33*	-.33*	.48*	.83*	.52*
Cs	.27+		-.32	.37+	.16	.44*	.44*	.83*	.22	.79*	-.62*	.52*	.12	.23+
Ba	.39*		-.22	.43*	.41*	.49*	.24+	.80*		.54*	-.35*	.54*		
La	.33*			.34+	.13	.34*	.38*	.65*	.21	.72*	-.51*	.52*	.16	.18
Ce	.31*	.14		.37+		.37*	.47*	.69*	.28+	.79*	-.59*	.48*	.23+	.23+
Sm		.22			-.27	.34*	.42*	.38*	.34*	.60*	-.35*	.40*	.40*	.41*
Eu		.33+		.12	-.37+	.35*	.49*	.39*	.53*	.67*	-.45*	.41*	.60*	.60*
Tb			-.13	.29		.32*	.19	.47*	.16	.45*	-.21	.29*	.24+	.28+
Dy		.29+			-.47*	.30*	.59*	.28+	.40*	.59*	-.42*	.17	.54*	.63*
Yb		.14	-.14		-.28	.31*	.51*	.55*	.26+	.66*	-.47*	.21	.36*	.51*
Lu		.21		.11	-.20	.16	.38*	.39*	.44*	.51*	-.43*	.25+	.45*	.37*
Hf	.42*	-.31+	-.17	.25	.43*	.11		.48*	-.18	.35*	-.23+		-.23+	-.19
Ta	.30*		-.21	.18		.43*	.41*	.68*		.69*	-.44*	.32*		.12
Pb	-.16	.55*	.14	.28	-.20	.16	.12		.30+		-.13	.31+	.31+	.20
Th	.42*		-.25	.34+	.28	.37*	.39*	.78*		.71*	-.47*	.39*		
U	-.31*	.65*	.29	.34+	-.38+	.22	.22	-.13	.69*	.18	-.28+	.49*	.78*	.37*

+ Significant at the 95% confidence level, * significant at the 99% confidence level.

TABLE 14. Correlation coefficient matrix for the chemical components of 185 samples of Grassy Creek and undifferentiated Grassy Creek-Sweetland Creek Shale.("Less than" values were not included in the analysis. Coefficients < ±0.1 were deleted.)

Zn	Ga	Ge	As	Se	Br	Rb	Sr	Zr	Mo	Ag	Sn	Sb	Cs	
1.00*		.36*		.53*						.85*		.42*		Zn
	1.00*		-.31*			.67*	-.21*	.20*	-.42*	-.16	.29*	-.37*	.65*	Ga
		1.00*		.62*	-.27+				-.16	.54*		.14		Ge
			1.00*	.12	-.12	-.38*		-.23*	.60*	.15	-.26*	.49*	-.34*	As
				1.00*	-.20	.31	.19	.19	-.33+	.80*	.35+	.86*	.58*	Se
					1.00*		-.15			.28				Br
						1.00*	-.16+	.25*	-.45*		.27*	-.23*	.84*	Rb
							1.00*			-.22			-.23*	Sr
								1.00*	-.35*	.15		-.14	.17+	Zr
									1.00*		-.20*	.29*	-.45*	Mo
										1.00*	-.16	.77*	.17	Ag
											1.00*	-.13	.28*	Sn
												1.00*		Sb
													1.00*	Cs

	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	S	Cl	CO_2	Org.C	F
SiO_2	1.00*													
Al_2O_3	-.31*	1.00*												
FeO	-.61*		1.00*											
MgO	-.41*	.48*		1.00*										
CaO	-.11	-.36*		.23*	1.00*									
Na_2O	.29*	-.23*		-.38*		1.00*								
K_2O	-.38*	.77*		.50*	-.37*	-.46*	1.00*							
TiO_2	-.24*	.76*		.42*	-.36*	-.28*	.64*	1.00*						
P_2O_5	-.13	-.20*	.17+		.51*		-.24*	-.25*	1.00*					
S	-.29*	-.48*	.79*	-.37*	.14	.12	-.45*	-.49*	.20*	1.00*				
Cl					-.13	.46*					1.00*			
CO_2		-.25*		.22*	.83*	.17+	-.30*	-.31*	.20*			1.00*		
Org.C	-.12	-.49*	.22*	-.48*	-.15+	.11	-.42*	-.44*		.49*		-.20*	1.00*	
F					.34*			-.16+	.57*			.14		1.00*
H_2O+	-.37*	.46*		.49*		-.46*	.56*	.48*	-.11	-.32*			-.45*	
Pyr.S	-.48*	-.55*	.90*	-.41*	.21		-.52*	-.49*	.24+	.98*	-.33*		.49*	
Sulf.S	-.15			.18	-.11	.15		-.17			.65*	-.28+		
SA-CO_2	-.52*	-.31*	.37*		-.20	-.46*		-.23		.42*	-.13	-.33*	.62*	-.26+
SA-N_2	-.14	.26+		.30+	-.13	-.56*	.51*	.30+	-.11	-.15	-.11	-.21	-.31*	-.16
Be	-.20*	.20*	.18+		-.24*		.14	.12	-.12			-.16+	.12	.13
B		.34*			-.16+	.31*	.11	.14		-.14	.15		-.17+	
Sc	-.41*	.84*		.45*	-.31*	-.26*	.78*	.68*	-.14	-.46*		-.21*	-.41*	
V	.37*	-.20*	-.38*	-.32*			-.13	-.16+		-.20*			.21*	
Cr		.47*	-.31*	.14	-.25*	-.11	.50*	.39*		-.53*		-.24*	-.14	
Mn	-.15+			.38*	.46*						-.17+	.47*	-.21*	
Co	-.50*		.62*							.61*			.40*	
Ni	.13	-.18+	-.13	-.39*		.14	-.15+	-.21*				-.12	.46*	
Cu					-.15+								.18+	
Zn	.12		-.21*	-.18+						-.16+		-.11	.20*	
Ga	-.38*	.83*		.43*	-.33*	-.21*	.74*	.68*	-.24*	-.39*		-.20*	-.41*	
Ge	.14	.15	-.23*					.18+		-.22*				.23*
As		-.42*	.54*	-.48*		.14	-.36*	-.36*		.76*			.56*	.18+
Se		.11	-.41*	-.24		-.31	.25		.40+	-.39+		-.23	.22	.51*
Br						.37*		-.14			.65*		.12	
Rb	-.37*	.75*		.44*	-.31*	-.33*	.82*	.61*	-.12	-.44*		-.26*	-.39*	
Sr		-.16+	.11		.55*	.17+	-.29*	-.24*	.88*	.17+	-.11	.32*		.50*
Zr		.30*		.16+	-.15+		.23*	.66*		-.30*	.12	-.19*	-.30*	
Mo		-.49*	.36*	-.29*			-.43*	-.46*		.63*	-.11		.70*	
Ag	.19	-.17	-.34+	-.37*	-.21		-.13		.53*	-.26	.22	-.19	.40*	.12
Sn	-.11	.34*	-.12	.21*			.24*	.30*		-.29*			-.14	
Sb	.25*	-.37*		-.55*	-.16+		-.27*	-.34*	.12	.22*		-.25*	.54*	
Cs	-.29*	.68*	-.12	.35*	-.35*	-.25*	.79*	.55*	-.18+	-.49*	.18+	-.30*	-.30*	
Ba	-.19*		.22*		.45*		-.14	-.15+	.92*	.16+		.19*		.50*
La	-.22*	.51*		.11			.33*	.61*	.21*	-.30*	-.12	-.12	-.17+	.15+
Ce	-.39*	.30*	.29*	.18+	.22*		.14	.33*	.68*				-.21*	.34*
Sm	-.23*		.20*		.33*				.79*	.14				.44*
Eu	-.30*		.30*		.37*		-.14		.86*	.25*		.13		.43*
Tb	-.20*		.22*		.31*		-.18+	-.14	.81*	.21*			.14	.39*
Dy	-.20*	-.13	.22*	-.14	.33*	.16+	-.23*		.83*	.22*		.11	.14	.43*
Yb	-.15+			-.11	.23*				.67*				.13	.43*
Lu		.13			.13			.13	.41*		-.19*			.16+
Hf	-.11	.32*		.21*	-.13		.27*	.61*		-.29*	.18+	-.16+	-.30*	-.11
Ta	-.18+	.50*		.34*	-.24*		.45*	.70*	-.21*	-.40*	.28*	-.18+	-.32*	-.18+
Pb	-.21*		.19+	-.15	-.15					.17+		-.14	.24*	
Th	-.33*	.66*		.45*	-.14	-.25*	.62*	.76*		-.42*		-.15+	-.44*	
U	-.11	-.44*	.34*	-.32*		.11	-.38*	-.44*		.60*		-.11	.74*	

Ba	La	Ce	Sm	Eu	Tb	Dy	Yb	Lu	Hf	Ta	Pb	Th	U	
	.27*				.21*	.14	.34*	.12			.16+			Zn
-.13	.49*	.24*			-.16+	-.17+			.26*	.47*		.60*	-.39*	Ga
.16	.26*						.18+				.18+			Ge
	-.12			.11		.13			-.27*	-.33*	.34*	-.37*	.60*	As
	.71*	.11	.23	.34+	.45*	.41*	.80*	.57*	.13		.39+		-.40+	Se
	-.22			-.13			-.13	-.11	.15		-.12			Br
	.35*	.25*					.11		.40*	.56*		.72*	-.42*	Rb
.78*	.21*	.62*	.65*	.72*	.69*	.66*	.56*	.36*		-.21*				Sr
	.48*	.39*	.25*	.13		.21*	.30*	.18+	.80*	.55*		.57*	-.34*	Zr
	-.35*	-.16+							-.36*	-.37*	.12	-.47*	.88*	Mo
-.24	.44*	-.12	.26	.20	.40*	.43*	.64*	.14			.21	-.17	-.12	Ag
.13	.19+							.20*		.15+		.18+	-.14	Sn
		-.20*			.15+	.18+	.32*	.17+	-.20*	-.29*	.42*	-.36*	.33*	Sb
-.11	.40*					-.13			.27*	.52*	.14	.63*	-.44*	Cs
1.00*	.17+	.73*	.78*	.87*	.80*	.82*	.63*	.36*		-.11		.15+		Ba
	1.00*	.55*	.45*	.40*	.32*	.35*	.59*	.43*	.45*	.43*	.18+	.53*	-.28*	La
		1.00*	.77*	.80*	.69*	.74*	.64*	.38*	.42*	.27*		.54*		Ce
			1.00*	.87*	.79*	.85*	.74*	.39*	.25*			.26*		Sm
				1.00*	.86*	.89*	.75*	.46*	.15+			.20*	.15+	Eu
					1.00*	.82*	.78*	.45*	.16+			.13	.16+	Tb
						1.00*	.78*	.39*	.20*			.16+	.13	Dy
							1.00*	.54*	.36*	.19*	.17+	.31*		Yb
								1.00*	.14			.15+		Lu
									1.00*	.70*		.72*	-.36*	Hf
										1.00*	-.11	.75*	-.38*	Ta
											1.00*		.19+	Pb
												1.00*	-.45*	Th
													1.00*	U

	H_2O+	Pyr.S	SulfS	SACO_2	SA-N_2	Be	B	Sc	V	Cr	Mn	Co	Ni	Cu
H_2O+	1.00*													
Pyr.S	-.24+	1.00*												
Sulf.S	.19	-.11	1.00*											
SA-CO_2		.38*	.28+	1.00*										
SA-N_2	.50*	-.18	.16	.45*	1.00*									
Be			-.12		-.12	1.00*								
B		-.28+	-.31+	-.54*	-.42*	.30*	1.00*							
Sc	.49*	-.50*			.45*	.17+	.30*	1.00*						
V	-.23*	-.18	-.20	-.15	-.30+	-.14		-.15+	1.00*					
Cr	.17+	-.54*		-.33*	-.13		.32*	.52*	.47*	1.00*				
Mn			-.11				-.12		-.14	-.15+	1.00*			
Co		.65*	.13	.56*		.21*	-.18+		-.42*	-.44*		1.00*		
Ni	-.44*	.11	-.22		-.35*		.16+	-.15+	.57*	.36*			1.00*	
Cu			-.16		-.38*	.33*	.41*			.13			.31*	1.00*
Zn	-.16+	-.19							.41*	.38*	-.13	-.13	.63*	.11
Ga	.48*	-.37*	-.23	-.25+	.18	.20*	.27*	.76*	-.17+	.43*			-.18+	
Ge		-.24+	-.39*	-.39*	-.26+				.16	.29*			.23*	
As	-.38*	.79*	-.15	.38*	-.25+	.12	-.12	-.44*		-.26*	-.11	.44*	.29*	
Se	-.27	-.37	-.35	-.12	-.47+		.12	.22	.70*	.85*	-.23	-.56*	.65*	
Br		-.34	.84*	.23	.33		-.12				-.12			
Rb	.46*	-.51*	.16		.53*	.20*	.23*	.91*		.55*			-.11	
Sr	-.13	.22		-.19	-.15	-.13	.15	-.14						
Zr	.22*	-.37*	.11	-.14	.34*			.29*		.19*	-.18+		-.21*	-.14
Mo	-.38*	.70*		.59*	-.19		-.23*	-.50*		-.47*		.56*	.27*	
Ag	-.32+	-.33			-.19		.12		.76*	.67*	-.27+	-.37*	.80*	
Sn	.16+	-.26+	-.12	-.40*	-.16	.20*	.21*	.28*		.24*		-.13		.20*
Sb	-.44*	.22		.19	-.22	-.12		-.31*	.65*	.27*	-.27*		.63*	
Cs	.44*	-.54*		-.14	.24+	.13	.30*	.78*	.11	.72*	-.12	-.22*		
Ba		.19		-.13										
La	.16+	-.20	-.34+	-.25+	-.11		.28*	.46*	.21*	.55*		-.17+	.20*	
Ce	.15+	.11					.15	.31*	-.21*			.17+		
Sm		.18	.11		-.14							.14	.11	
Eu		.32*			-.11		.15					.21*	.12	
Tb	-.14	.24+		.11			.15					.16+	.20*	
Dy	-.16+	.25+			-.11		.11					.15+	.17+	
Yb	-.14						.14	.14	.26*	.29*			.34*	
Lu				-.12			.21*		.17+	.23*	.11		.22*	.19*
Hf	.17+	-.36*	.14		.47*			.43*	-.12	.22*			-.20*	
Ta	.28*	-.50*	.22	-.14	.19	.20*	.15	.59*	-.11	.36*			-.13	
Pb		.19		.28+		-.11				.14	-.24*		.24*	
Th	.42*	-.44*		-.16	.39*	.18+	.16+	.76*	-.21*	.39*			-.20*	
U	-.41*	.66*		.62*	-.19		-.23*	-.46*		-.45*		.60*	.27*	

+ Significant at the 95% confidence level, * significant at the 99% confidence level.

TABLE 15. Correlation coefficient matrix for the chemical components of 60 samples of Hannibal-Saverton Shale.("Less than" values were not included in the analysis. Coefficients < ±0.1 were deleted.)

Zn	Ga	Ge	As	Se	Br	Rb	Sr	Zr	Mo	Sn	Sb	Cs	
1.00*				.95				.13	.36+	.28+	.59*	.13	Zn
	1.00*	-.27+		.49	-.29	.76*	-.37*	-.45*		.38*	.17	.79*	Ga
		1.00*	-.33+		-.12	-.31+		.48*	-.22	-.16	-.15	-.27+	Ge
			1.00*	-.45	-.48			-.29+	.26				As
				1.00*		.21	.42	-.16	.85	.98+	.97+	.63	Se
					1.00*		-.18	.49+		.16		-.14	Br
						1.00*	-.51*	-.40*	-.12	.22		.86*	Rb
							1.00*	-.22		.15		-.48*	Sr
								1.00*	-.14	-.12	-.13	-.36*	Zr
									1.00*	.60*	.85*		Mo
										1.00*	.62*	.41*	Sn
											1.00*	.19	Sb
												1.00*	Cs

	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	S	Cl	CO_2	Org.C	F
SiO_2	1.00*													
Al_2O_3	-.20	1.00*												
FeO	-.36*	.77*	1.00*											
MgO	-.66*	.16	.30+	1.00*										
CaO	-.69*	-.45*	-.26+	.33*	1.00*									
Na_2O	.73*	-.55*	-.67*	-.66*	-.20	1.00*								
K_2O	-.30+	.85*	.68*	.37*	-.40*	-.62*	1.00*							
TiO_2	.81*	.17		-.48*	-.80*	.36*		1.00*						
P_2O_5		-.64*	-.57*	-.18	.41*	.35+	-.54*	-.20	1.00*					
S	-.21	.21	.53*			-.24	.26+	-.24	-.33+	1.00*				
Cl	.71*	-.31+	-.42*	-.58*	-.36*	.86*	-.40*	.47*		-.22	1.00*			
CO_2	-.78*	-.34*	-.18	.56*	.95*	-.36*	-.25	-.83*	.29		-.49*	1.00*		
Org.C		.34*	.18	-.37*	-.30+		.24		-.20	.35*		-.35*	1.00*	
F	-.24	.55*	.33+	.21	-.22	-.36*	.60*		-.20	.12	-.29+		.46*	1.00*
H_2O+	-.25	.35*	.35*	.13		-.47*	.29+		-.40*		-.33*			.21
Pyr.S	-.31+	.37*	.65*	.30+		-.42*	.45*	-.24	-.39+	.95*	-.37*		.17	.13
Sulf.S	.82*	-.13	-.46+	-.62*	-.59*	.85*	-.38	.51+		-.22	.87*	-.55+	.50+	.23
SA-CO_2	-.63*	.76*	.65*	.53*	-.12	-.78*	.91*	-.24	-.48*	.18	-.61*		.15	.65*
SA-N_2	-.64*	.68*	.59*	.63*		-.78*	.83*	-.20	-.45*		-.66*	.20		.55*
Be		.70*	.53*	.15	-.55*	-.35*	.73*	.25	-.50*		-.14	-.42*	.22	.50*
B		.44*	.36*	-.28+	-.13	-.11	.28+		-.24	.11		-.14	.38*	.20
Sc	-.20	.75*	.64*	.24	-.43*	-.40*	.80*		-.60*	.23	-.13	-.35*	.27+	.53*
V		.11		-.26+	-.11	.13					.14	-.20	.61*	.35*
Cr	.32+	.28+		-.29+	-.54*	.23	.25	.39*	-.28		.32+	-.72*	.52*	.43*
Mn	-.65*	-.23		.42*	.77*	-.30+	-.19	-.71*	.22		-.37*	.78*	-.27+	-.16
Co	-.44*	.60*	.59*	.30+		-.58*	.58*	-.17	-.47*	.36*	-.45*		.44*	.60*
Ni		.18		-.30+	-.15				-.12		.14	-.25	.69*	.37*
Cu		.17		-.34*		.15		-.14		.23	.17		.64*	.25
Zn	.28+			-.34*	-.24	.30+	-.14	.14	-.16	.22	.27+	-.28+	.44*	
Ga		.87*	.67*		-.50*	-.40*	.81*	.21	-.63*	.18	-.16	-.43*	.32+	.51*
Ge	.47*	-.29+	-.49*	-.44*	-.17	.51*	-.31+	.34*	.34+	-.25	.29+	-.22		-.17
As	-.34*	.19	.26+	.34*		-.46*	.17	-.18	-.34+	.31+	-.36*	.18		
Se	-.16	.73	-.40		-.44	.29			-.57	-.63	.21	.15	.74	.76
Br	.37	-.54+	-.52+	-.19	-.22	.61*	-.42		.18	-.28	.80*	-.27		-.27
Rb	-.14	.71*	.61*	.23	-.46*	-.40*	.82*	.14	-.52*	.18	-.15	-.39*	.17	.47*
Sr	-.42*	-.35*	-.33*		.79*	.12	-.46*	-.61*	.34+			.67*		-.14
Zr	.84*	-.58*	-.62*	-.54*	-.34*	.76*	-.59*	.60*	.36+	-.35*	.67*	-.43*	-.21	-.52*
Mo		.12	.17	-.37+	-.16					.38+	-.13	-.20	.84*	.37+
Sn		.34*	.15	-.39*	-.21	.13	.11		-.17		.26+	-.32+	.60*	.22
Sb		.17		-.29+	-.16				-.11	.22		-.21	.83*	.38*
Cs		.75*	.64*		-.53*	-.34*	.76*	.24	-.53*	.18	-.11	-.48*	.33*	.47*
Ba	.37*	.40*	.25	-.41*	-.49*	.18	.13	.54*	-.30+		.39*	-.57*	.23	
La	.47*	.11	-.21	-.31+	-.37*	.40*		.52*		-.27+	.35*	-.38*		.17
Ce	.65*	-.20	-.23	-.34*	-.43*	.42*	-.22	.73*	.25	-.35*	.43*	-.51*	-.35*	-.39*
Sm	.35*	-.39*	-.47*	-.33*		.48*	-.41*	.12	.69*	-.18	.29+			
Eu	.34*	-.56*	-.50*	-.30+		.52*	-.51*		.78*	-.16	.31+			-.21
Tb	.34*	-.68*	-.60*	-.16	.11	.54*	-.53*		.69*	-.21	.37*		-.26+	-.36*
Dy	.62*	-.60*	-.62*	-.52*		.75*	-.63*	.34*	.68*	-.30+	.58*	-.22		-.34*
Yb	.61*	-.61*	-.67*	-.32+	-.11	.70*	-.58*	.36*	.48*	-.29+	.55*	-.16	-.17	-.35*
Lu	.53*	-.48*	-.59*	-.32+	-.15	.61*	-.40*	.35*	.41*	-.22	.45*	-.21		-.13
Hf	.71*	-.65*	-.66*	-.35*	-.21	.68*	-.55*	.46*	.41*	-.33*	.54*	-.29+	-.32+	-.54*
Ta	.66*		-.17	-.29+	-.58*	.46*		.68*		-.18	.53*	-.61*		-.13
Pb	-.11	-.23			.19		-.23	-.21		.30+			.26	
Th	.44*	.21			-.64*	.14	.32+	.56*	-.28		.28+	-.61*		
U		.27		-.49+	-.42				.32	.30		-.39	.88*	.23

	Ba	La	Ce	Sm	Eu	Tb	Dy	Yb	Lu	Hf	Ta	Pb	Th	U
Zn	.18	.12									.16	.17		.17
Ga	.45*		-.11	-.37*	-.49*	-.59*	-.50*	-.54*	-.41*	-.51*		-.12	.35*	
Ge		.42*	.21	.33+	.34*	.26	.43*	.44*	.48*	.42*	.19	-.28+		-.27
As		-.17	-.15	-.26+	-.31+	-.22	-.37*	-.28+	-.38*	-.22	-.23			.23
Se	-.20	.76	-.66	-.27	.61	-.86		.67	.99*	-.23	.61	.89	.78	.55
Br	-.11	-.37	.30		.20	.34	.31	.45	.22	.48	.49+	-.13	.12	.56
Rb	.35*			-.40*	-.36*	-.34*	-.50*	-.39*	-.24	-.33*	.28+	-.14	.60*	
Sr	-.23		-.39*	.21	.16					-.20	-.47*	.29+	-.59*	-.46
Zr	.12	.30+	.74*	.45*	.51*	.60*	.74*	.76*	.63*	.93*	.58*		.31+	-.17
Mo			-.21	.18		-.19			.11	-.31		.38+	-.16	.89*
Sn	.46*	.15				-.16				-.26+		.45*		.67*
Sb	.14	.18	-.25			-.19				-.22		.27		.70*
Cs	.41*			-.35*	-.36*	-.41*	-.43*	-.46*	-.32+	-.35*	.28+		.58*	.22
Ba	1.00*	.33*	.32+			-.11					.42*	-.12	.36*	
La		1.00*	.34*	.45*	.30+	.17	.42*	.51*	.52*	.23	.41*	-.18	.33*	
Ce			1.00*	.35*	.42*	.47*	.56*	.54*	.40*	.72*	.69*	-.26	.54*	-.40
Sm				1.00*	.87*	.69*	.78*	.63*	.60*	.42*	.17			.24
Eu					1.00*	.79*	.85*	.71*	.64*	.55*	.24			.32
Tb						1.00*	.72*	.76*	.65*	.68*	.39*		.19	-.24
Dy							1.00*	.80*	.70*	.71*	.33*		.11	.17
Yb								1.00*	.84*	.76*	.55*		.24	.18
Lu									1.00*	.66*	.49*		.30+	.38
Hf										1.00*	.58*	-.17	.38*	-.33
Ta											1.00*		.77*	-.13
Pb												1.00*	-.16	.72*
Th													1.00*	-.15
U														1.00*

	H_2O+	Pyr.S	SulfS	$SACO_2$	SA-N_2	Be	B	Sc	V	Cr	Mn	Co	Ni	Cu
H_2O+	1.00*													
Pyr.S	.16	1.00*												
Sulf.S	-.35	-.41	1.00*											
SA-CO_2	.45*	.33+	.11	1.00*										
SA-N_2	.41*	.27	.26	.95*	1.00*									
Be	.34*	.27	-.20	.65*	.58*	1.00*								
B		.21		.19		.42*	1.00*							
Sc	.36*	.29+	-.31	.66*	.55*	.70*	.24	1.00*						
V	-.14	-.11	.45+	-.26	-.39*		.32+		1.00*					
Cr			.52+	.18		.32+	.22	.43*	.76*	1.00*				
Mn			-.46+	-.12		-.39*		-.18	-.11	-.46*	1.00*			
Co	.33*	.45*	-.11	.64*	.59*	.43*	.31+	.58*	.42*	.38*		1.00*		
Ni			.41		-.15	.14	.36*	.17	.95*	.77*	-.15	.51*	1.00*	
Cu		.12	.11	-.22	-.40*		.52*	.16	.45*	.27+	.18	.28+	.53*	1.00*
Zn		.15	.49+	-.37*	-.43*		.25		.67*	.57*	-.27+	.23	.66*	.35*
Ga	.41*	.30+	-.22	.68*	.57*	.74*	.44*	.79*	.13	.36*	-.32+	.54*	.22	.19
Ge	-.23	-.37*	.81*	-.33+	-.26	-.26		-.38*			-.26	-.48*		-.13
As	.20	.36*	-.41	.17	.22	.13				-.24	.14	.43*		
Se	-.69	-.69	.94	-.60		.23	.82	.59	.99*	.99*	-.50	.93	.98+	.71
Br	-.11	-.40	-.98	-.39	-.43	.12	-.34	-.12			-.36	-.37		
Rb	.34*	.29+	-.42	.73*	.62*	.75*	.17	.93*		.36*	-.29+	.50*		
Sr	-.16	-.13		-.37*	-.37*	-.53*		-.41*		-.30+	.65*			.29+
Zr	-.39*	-.45*	.50+	-.76*	-.71*	-.30+	-.28+	-.49*			-.41*	-.62*	-.11	-.15
Mo		.21	.31		-.16		.26		.55*	.40+	-.19	.48*	.59*	.58*
Sn		-.17	.16	-.12	-.27	.23	.52*	.36*	.59*	.49*		.25	.64*	.69*
Sb			.39		-.29+		.33+	.13	.86*	.65*	-.13	.49*	.87*	.56*
Cs	.33*	.26	-.15	.65*	.52*	.71*	.30+	.82*	.17	.45*	-.34*	.50*	.26+	.11
Ba	.21		.35		-.17	.41*	.28+	.39*	.12	.32+	-.35*	.23	.24	.31+
La	-.14	-.24	.68*	-.18					.25	.45*	-.30+		.22	.18
Ce		-.31+	-.35	-.54*	-.44*		-.18	-.13	-.14		-.41*	-.39*	-.17	-.28+
Sm	-.29+	-.27	.15	-.54*	-.56*	-.37*		-.39*				-.31+		.31+
Eu	-.35*	-.30+		-.61*	-.60*	-.47*	-.23	-.38*			.12	-.39*		.16
Tb	-.38*	-.32+	-.12	-.66*	-.64*	-.43*	-.34*	-.39*	-.16	-.13		-.50*	-.21	
Dy	-.40*	-.46*	.42	-.77*	-.74*	-.47*	-.20	-.50*				-.54*		.13
Yb	-.38*	-.41*	.51+	-.73*	-.66*	-.44*	-.36*	-.37*		.13		-.48*		
Lu	-.29+	-.37*	.64*	-.47*	-.43*	-.41*	-.42*	-.24		.21	-.22	-.37*		
Hf	-.38*	-.40*	.16	-.71*	-.62*	-.31+	-.40*	-.45*	-.15		-.32+	-.58*	-.22	-.26+
Ta		-.23	.35	-.31+	-.31+	.18	-.14	.21		.38*	-.53*	-.19		
Pb		.24			-.19	-.32+	-.27		.13				.20	.24
Th						.39*		.50*		.39*	-.50*	.12		
U			.54		-.30	-.13	.41	.11	.34	.24	-.33	.32	.40	.67*

+ Significant at the 95% confidence level, * significant at the 99% confidence level.

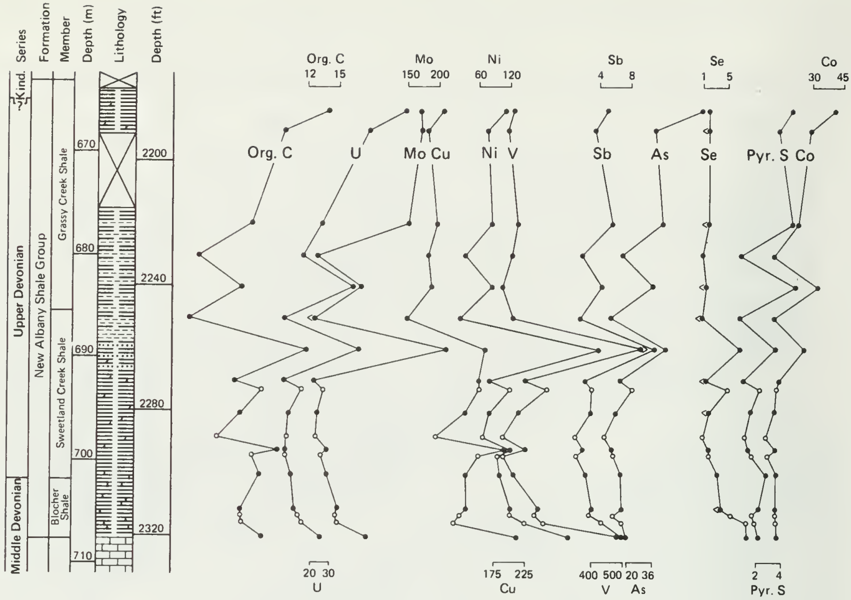
TABLE 16. Correlation coefficient matrix for the chemical components of 25 samples in the Hardin Co. (11IL) core. (Sample S00378 not included. "Less than" values were not included in the analysis. Coefficients < ±0.1 were deleted.)

Zn	Ga	Ge	As	Se	Rb	Sr	Zr	Mo	Ag	Sn	Sb	Cs	Ba	
1.00*			.19	.28	-.30	.82*	-.14		-.14				-.14	Zn
	1.00*	.29	-.18		.29		.45+		-.45	.22	-.19	.43+	.47+	Ga
		1.00*		.62	.22	-.20	-.17	.11	.15	.17	-.16	.34		Ge
			1.00*	.67	-.23	.19	-.46+	.72*	.32		.59*		-.25	As
				1.00*	.31	-.24		.84	.80	.63	-.36	.26	.20	Se
					1.00*	-.55*	-.11		-.18	.29	-.40+	.46+	.35	Rb
						1.00*				-.21	.15	-.30		Sr
							1.00*	-.24	-.43	.13	-.23	-.17	.47+	Zr
								1.00*	.46	.22	.24	.43	.32	Mo
									1.00*			-.11		Ag
										1.00*	-.17	.35	.12	Sn
											1.00*	-.24	-.42+	Sb
												1.00*	.41+	Cs
													1.00*	Ba

	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	S	Cl	CO_2	Org.C	F
SiO_2	1.00*													
Al_2O_3	.15	1.00*												
FeO	-.26	.11	1.00*											
MgO	-.80*	-.45+		1.00*										
CaO	-.78*	-.56*	-.11	.93*	1.00*									
Na_2O	-.23	-.28		.11	.20	1.00*								
K_2O		.50*			-.16	-.51*	1.00*							
TiO_2		.78*	.12	-.24	-.38	-.22	.42+	1.00*						
P_2O_5	.30	-.35		-.23			-.21		1.00*					
S	.19		.52*	-.49+	-.31	.17	-.35	-.21	.31	1.00*				
Cl	-.74*	-.32	.28	.67*	.72*			-.25	-.16	-.12	1.00*			
CO_2	-.85*	-.47+		.98*	.95*	.13		-.23	-.18	-.43+	.73*	1.00*		
Org.C	.42+			-.64*	-.49+	.20	-.38	-.21	.34	.58*	-.29	-.61*	1.00*	
F	.27		-.15	-.18		-.21	.14	-.24			-.15	-.19		1.00*
H_2O+		.68*	.11	-.19	-.30	-.65*	.37	.68*	-.12	-.12		-.20	-.19	
Pyr.S	.17		.53*	-.50*	-.32	.17	-.35	-.17	.31	.99*		-.43+	.61*	
Sulf.S		.22	.19	-.28	-.15	-.19	-.42			.44	.33	-.29	.43	-.19
SA-CO_2	.40			-.63*	-.52+	-.14	-.34	-.11	.20	.42	-.30	-.66*	.84*	
SA-N_2	.34	.65*	.12	-.38	-.51+	-.67*	.18	.57*	-.13	-.12	-.24	-.43		
Be	.26	-.17	-.31			-.36	.11		.52*	-.15	-.13			.26
B	.30	.70*		-.34	-.44+	-.70*	.26	.56*	-.21	-.12	-.16	-.38	-.13	.20
Sc	-.48+	.25		.30	.33		.13	.25	-.16	-.19	.22	.30	-.14	
V	.16	.11		-.25	-.28	-.17			.31	.14	-.14	-.27	.37	
Cr	-.14	.29				-.13	.39	.46+		-.30				-.54*
Mn	-.54*		.30	.57*	.48+	-.26	.20	.24		-.40+	.52*	.62*	-.64*	
Co	-.17				.15	.21					.22			-.21
Ni	.37			-.56*	-.52*	.13	-.17	-.13	.25	.41+	-.36	-.55*	.87*	-.22
Cu	.42+		-.28	-.51*	-.41+	.23	-.28	-.26	.15	.41+	-.38	-.57*	.79*	.15
Zn	.35	-.17	-.41+	-.19			-.25	.11	.81*	.11	-.18	-.20	.26	.21
Ga		.65*	.11	-.14	-.18	-.20	.26	.61*	-.13		-.15	-.16	-.22	.16
Ge		.20	-.20		-.16				-.17		-.30	-.17	.20	.12
As	.36	-.17	.39	-.60*	-.44+	.19	-.36	-.22	.47+	.83*	-.23	-.53*	.73*	
Se	.17			-.18	-.46	-.29	-.11	-.17	.71			-.21	.50	.26
Rb		.51*			-.24	-.50*	.88*	.33	-.28	-.19	-.12		-.16	
Sr		-.43+	-.35		.27		-.39	-.15	.71*		.17		.17	.18
Zr	-.50*	.18		.47+	.39	.12		.40+	-.20	-.39	.39	.48+	-.61*	-.29
Mo	.20	.22	.46	-.66*	-.67*		-.13	.29	.16	.49+		-.61*	.70*	-.25
Ag	.33	-.49			-.14	-.13	-.28	-.35	.26				.47	-.16
Sn		.49+		-.17	-.22		.35	.42+		-.13	-.19	-.15		
Sb	.21	-.14		-.31	-.19	.58*	-.46+	-.26	.16	.41+	-.21	-.31	.43+	
Cs	.33	.74*		-.49+	-.59*	-.70*	.29	.50+	-.21		-.24	-.54*	.17	
Ba	-.30	.41+	.17	.11		-.44+	.40+	.30	-.25	-.14	.51*	.13	-.20	
La	.11	.29		-.14	-.22	-.24	.22	.51*	.18	-.13		-.15		-.34
Ce		.49+		-.21	-.29	-.37	.39	.64*		-.22		-.20		-.30
Sm		.42+		-.15	-.21	-.12	.11	.44+			.12	-.14	.27	-.35
Eu		.39		-.21	-.24	-.24		.46+	.19		.14	-.20	.36	-.30
Tb	-.26	.55*	.23			-.31	.17	.57*			.12			
Dy	-.27	.33						.39	.11				.15	
Yb	-.38	.17		.19	.29	.15	-.14	.27			.18	.21		-.17
Lu	-.31		-.19	.26	.35	.28	-.23	.17	.22			.25		-.11
Hf	-.43+			.46+	.39		.22	.37		-.47+	.29	.47+	-.57*	-.26
Ta		.40+		-.17	-.22	-.19	.17	.77*	.43+	-.15	-.15	-.16		-.18
Pb	.16		.38	-.53*	-.36	.27	-.32	-.14	.14	.84*	-.19	-.48+	.64*	.15
Th	-.37	-.16		.32	.41+	.36	-.23			-.11	.39	.34		-.21
U	.24	.21	-.12	-.60+	-.46		-.20			.31	-.16	-.56+	.87*	
W	-.28	-.11			.12	.38		.22	.26			.15	.24	-.41+

	La	Ce	Sm	Eu	Tb	Dy	Yb	Lu	Hf	Ta	Pb	Th	U	W	
	.25	.21		.31		.22	.21	.39		.58*		.14		.17	Zn
	.36	.43+	.37	.37	.69*	.53*	.44+	.42+	.22	.44+		.21	-.29		Ga
	-.13			.16	.32	.20		.11	-.26		.19	-.24	.14	-.16	Ge
				.14					-.43+	-.11	.76*		.38	.11	As
	-.53			.38	.23	.18		.19	.17		-.37	-.76		-.40	Se
		.24	.12	.16	.32			-.18			-.15	-.35		-.14	Rb
	.31	.19		.23		.24	.33	.44+	.20	.36		.50*		.29	Sr
	.41+	.38	.25	.15	.28	.31	.44+	.38	.88*	.29	-.40+	.57*	-.50+	.19	Zr
	.36	.41	.26	.44	.27	.12		-.16	-.25	.17	.44		.41	.14	Mo
	.14				-.18	-.22	-.25	-.25	-.38	-.26	-.19	-.20	.23		Ag
		.24	.15	.22	.32	.27	.15		.19	.18					Sn
	-.22	-.30	-.23	-.17	-.24			.16	-.23	-.20	.58*	.14	.31		Sb
	.17	.39	.37	.47+	.60*	.22			-.20	.28	.12	-.34	.33	-.34	Cs
	.53*	.62*	.56*	.54*	.57*	.30	.32		.35	.22	-.15	.31	.11		Ba
	1.00*	.93*	.69*	.66*	.37	.23	.21		.36	.57*	-.18	.44+	-.14	.26	La
		1.00*	.76*	.75*	.53*	.35	.31	.11	.38	.62*	-.20	.36		.30	Ce
			1.00*	.87*	.63*	.49+	.38	.15	.16	.47+		.33	.49	.42+	Sm
				1.00*	.72*	.56*	.45+	.27	.13	.59*		.26	.51+	.32	Eu
H_2O+	1.00*				1.00*	.80*	.72*	.52*	.20	.47+	.13	.30	.26		Tb
Pyr.S		1.00*				1.00*	.93*	.82*	.28	.38	.20	.54*	.40	.30	Dy
Sulf.S	.33	.45	1.00*				1.00*	.90*	.42+	.26		.68*	.17	.28	Yb
SA-CO_2	.17	.45+	.57+	1.00*				1.00*	.36	.29		.63*	-.12	.23	Lu
SA-N_2	.81*	-.11	.33	.35	1.00*				1.00*	.35	-.45+	.50*	-.52+	.26	Hf
Be		-.16	-.13	.13	.60*	1.00*				1.00*	-.21	.15		.36	Ta
B	.85*	-.12	.44	.26	.94*	.14	1.00*				1.00*		.55+		Pb
Sc	.30	-.18			.19		.18	1.00*				1.00*	-.19	.38	Th
V	.24	.17	.25	.38	.15	.12	.13	.21	1.00*				1.00*	.44	U
Cr	.16	-.26						.45+	.27	1.00*				1.00*	W
Mn	.28	-.38	-.38	-.46+	.31	.12	.14	.22	-.23		1.00*				
Co	-.19		.18		-.24	.25	-.18	.13		.44+		1.00*			
Ni		.45+	.38	.77*	-.11	-.12	-.13	-.15	.56*	.14	-.65*		1.00*		
Cu	-.25	.41+	.41	.71*	-.13				.34		-.73*		.75*	1.00*	
Zn		.12		.41	.31	.58*			.29		-.17		.11	.20	
Ga	.66*		.17	-.19	.48+	-.16	.53*	.63*	.18	.26	.15		-.18	-.12	
Ge	.25			.38	.16	-.26	.19	.30	.29		-.14	-.40+	.29	.44+	
As	-.27	.84*	.37	.51+	-.14		-.20	-.28	.37		-.54*	.13	.65*	.52*	
Se				.31	-.11	-.39		.11	.90+	.75	-.25	-.29	.95*	.29	
Rb	.37	-.19	-.29		.17	-.16	.27	.22	.12	.41+		-.13			
Sr	-.18		.17		-.21	.64*	-.18		.12			.37		.14	
Zr	.20	-.38		-.59*				.37		.34	.47+	.44+	-.49+	-.53*	
Mo	.14	.55+	.44	.52	.23	-.14	.16	-.17	.55+	.18	-.37	.22	.72*	.34	
Ag	-.21		-.22	.31	-.24	.11	-.23	-.28	.51	.13	-.17	-.26	.54		
Sn	.26	-.11			.30		.21	.11	.39	.14			.17		
Sb	-.45+	.39	.11	.18	-.37		-.32	-.17	.15	-.20	-.52*	.25	.35	.51*	
Cs	.76*		.47	.50+	.82*		.88*	.14	.31	.19		-.21	.21	.21	
Ba	.44+	-.12	.48		.26		.44+	.42+		.42+	.27	.25	-.18	-.22	
La	.31		.17	-.17	.27	.28	.27	.14	.19	.58*	.14	.36			
Ce	.49+	-.17	.20		.42	.27	.43+	.28	.28	.71*	.11	.38			
Sm	.34		.36	.29	.32		.30	.41+	.21	.60*		.24	.28	.12	
Eu	.44+	.14	.48	.39	.36		.34	.40+	.51*	.58*		.25	.38	.22	
Tb	.60*		.48	.29	.59*		.55*	.74*	.36	.49+	.21	.13			
Dy	.24	.13	.35	.25	.29		.18	.80*	.31	.49+		.31		.13	
Yb	.14		.37		.16			.81*	.24	.51*		.45+			
Lu			.13			.11		.75*	.24	.40+		.29			
Hf	.13	-.46+		-.56*		.27		.27		.41+	.43+	.61*	-.42+	-.47+	
Ta	.47+	-.11			.51+	.40+	.34	.18	.15	.40+	.25	.18		-.15	
Pb	-.12	.83*	.53+	.56*		-.17			.13	-.28	-.52*		.49+	.62*	
Th	-.22		.16	-.27	-.20	.12	-.21	.53*		.42+	.12	.57*	-.15		
U		.35	.50	.85*		-.19			.13	.16	-.54+	.25	.81*	.67*	
W			-.21		-.22	.14	-.35	.21		.39		.42+	.21		
	H_2O+	Pyr.S	SulfS	SACO_2	SA-N_2	Be	B	Sc	V	Cr	Mn	Co	Ni	Cu	

+ Significant at the 95% confidence level, * significant at the 99% confidence level.



Concentration Unit												
%				ppm								
SiO_2	CaO	P_2O_5	Pyr.S	Be	Cr	Cu	Se	Mo	La	Tb	Hf	U
Al_2O_3	Na_2O	CO_2		B	Mn	Zn	Rb	Sb	Ce	Dy	Ta	
FeO	K_2O	Org.C		Sc	Co	Ga	Sr	Cs	Sm	Yb	Pb	
MgO	TiO_2	F		V	Ni	As	Zr	Ba	Eu	Lu	Th	

● Sample taken for released gas and chemical analyses
○ Sample taken for lithologic study

Figure 2. Lithology and distribution with depth of the concentrations of the elements in the Christian County, Kentucky core (01KY). Note the shale unit below Grassy Creek was termed Selmier by the Illinois State Geological Survey (Bergstrom, Shimp, and Cluff, 1980) but the Kentucky Geological Survey applies the term Sweetland Creek to this section of the Devonian in the subsurface in western Kentucky. Samples from this part of the core are labelled Selmier by ISGS in this report.

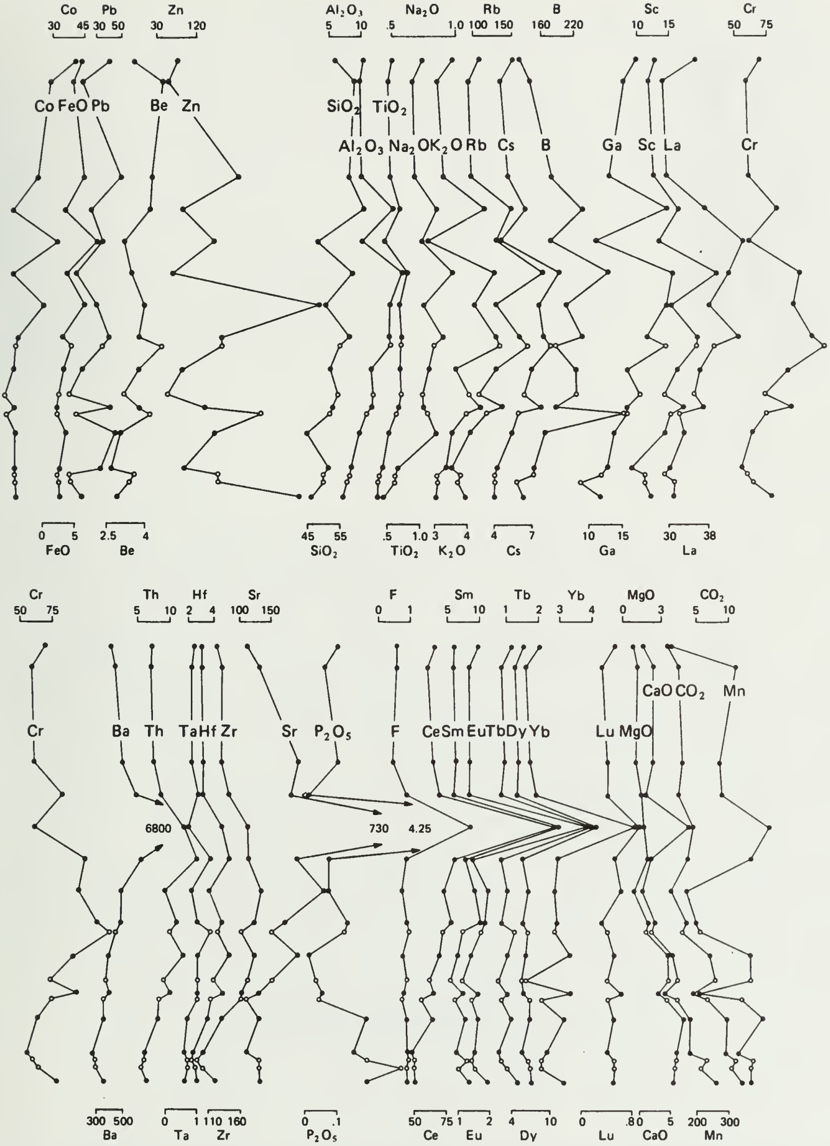


Figure 2. Core 01KY continued

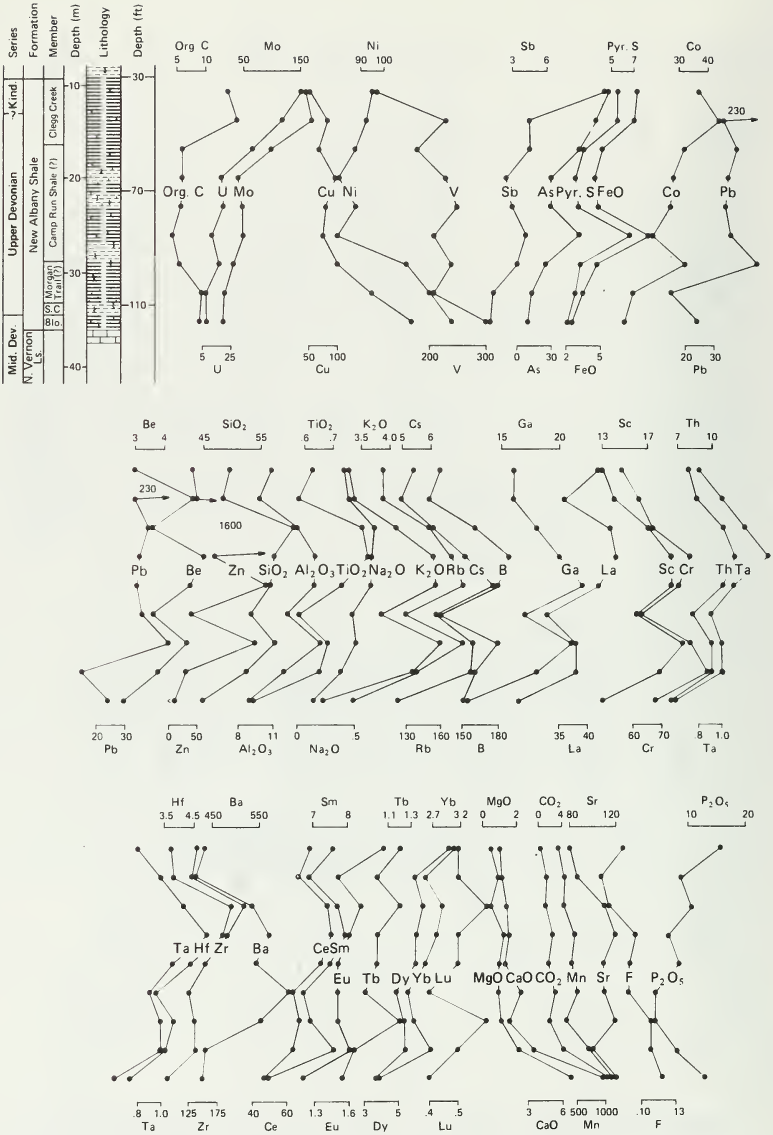


Figure 3. Lithology and distribution with depth of the concentrations of the elements in the Bullitt County, Kentucky core (02KY).

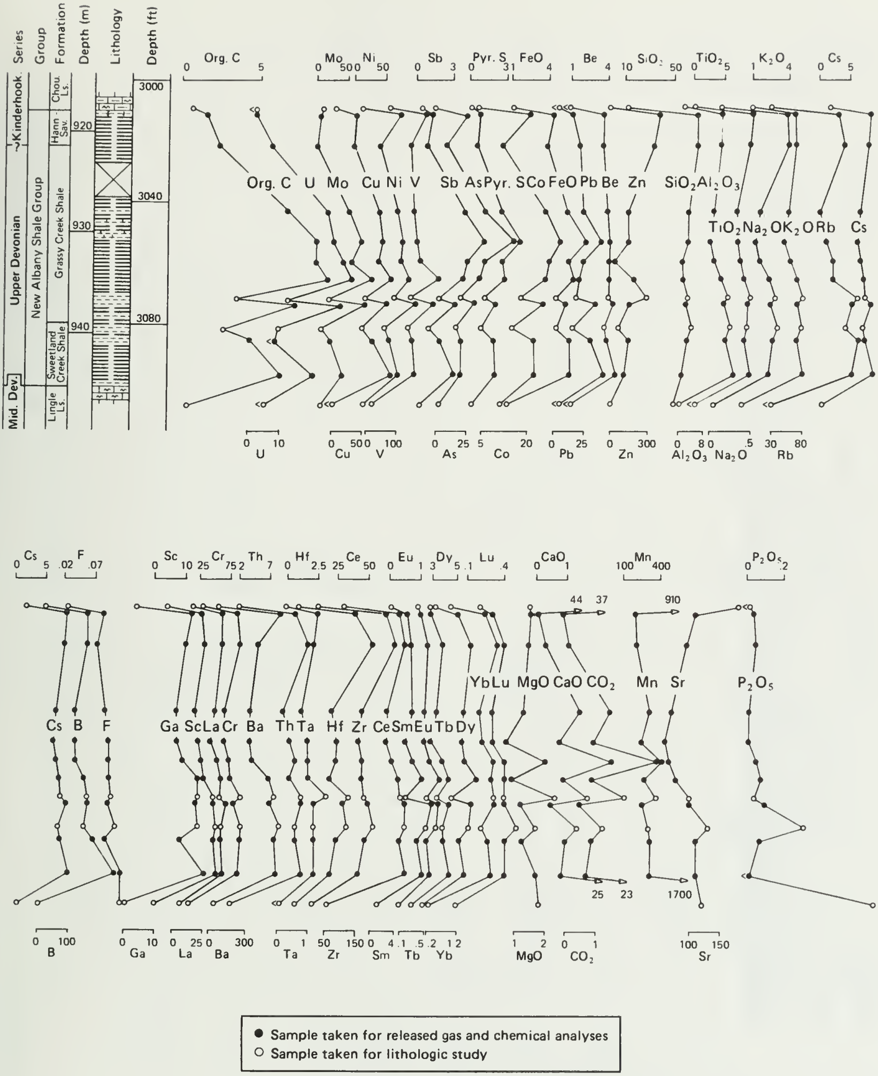


Figure 4. Lithology and distribution with depth of the concentrations of the elements in the Effingham County, Ill. core (021L).

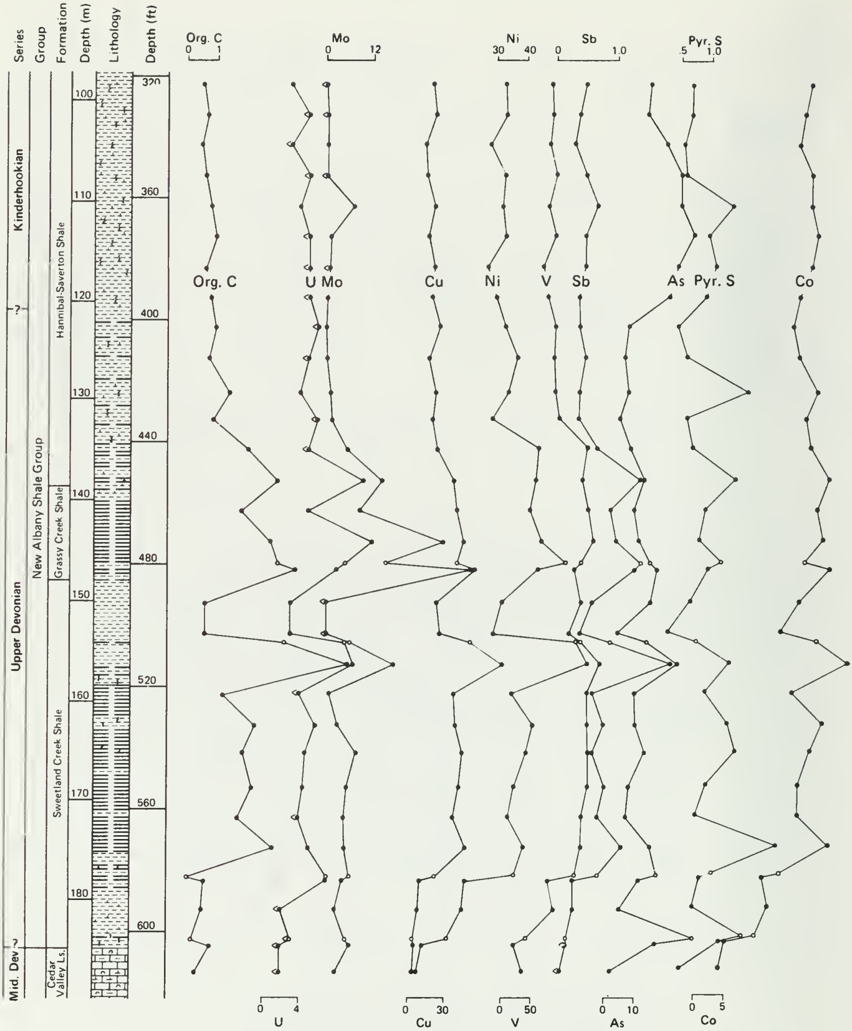
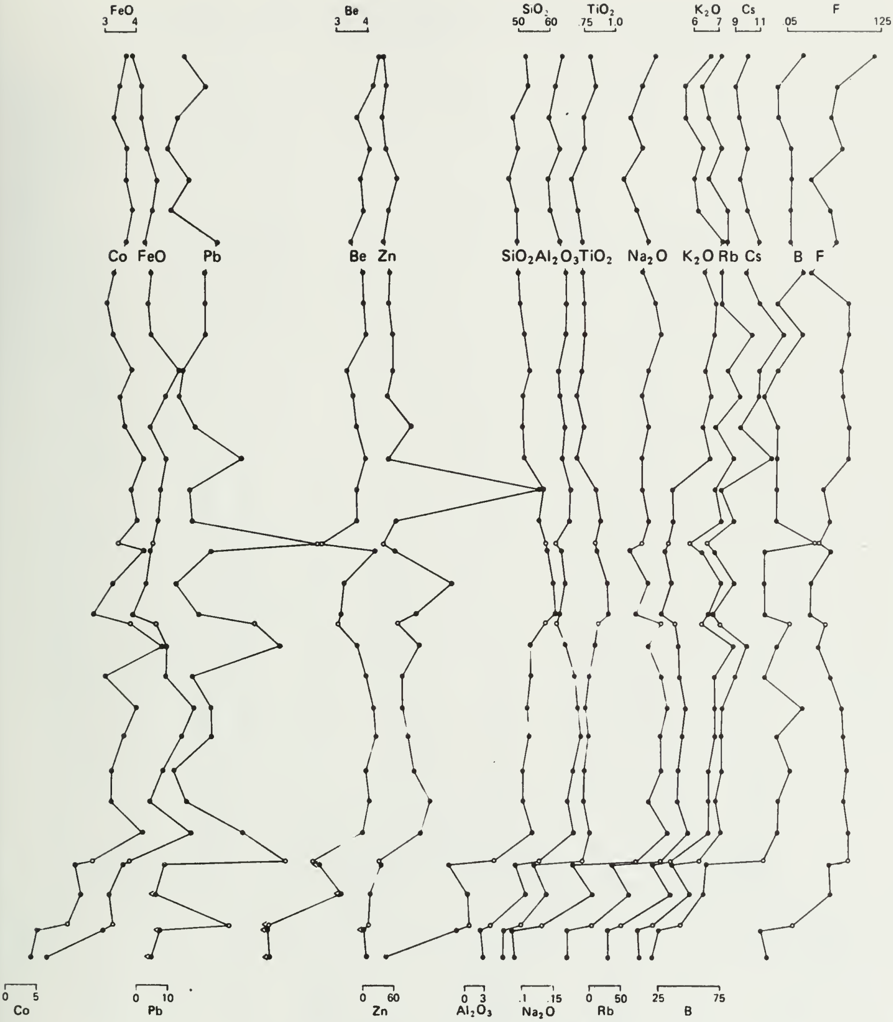


Figure 5. Lithology and distribution with depth of the concentrations of the elements in the Henderson County, Ill. core (041L).



Concentration Unit												
%				ppm								
SiO_2	CaO	P_2O_5	Pyr.S	Be	Cr	Cu	Se	Mo	La	Tb	Hf	U
Al_2O_3	Na_2O	CO_2		B	Mn	Zn	Rb	Sb	Ce	Dy	Ta	
FeO	K_2O	Org.C		Sc	Co	Ga	Sr	Cs	Sm	Yb	Pb	
MgO	TiO_2	F		V	Ni	As	Zr	Ba	Eu	Lu	Th	

Figure 5. Core 041L continued

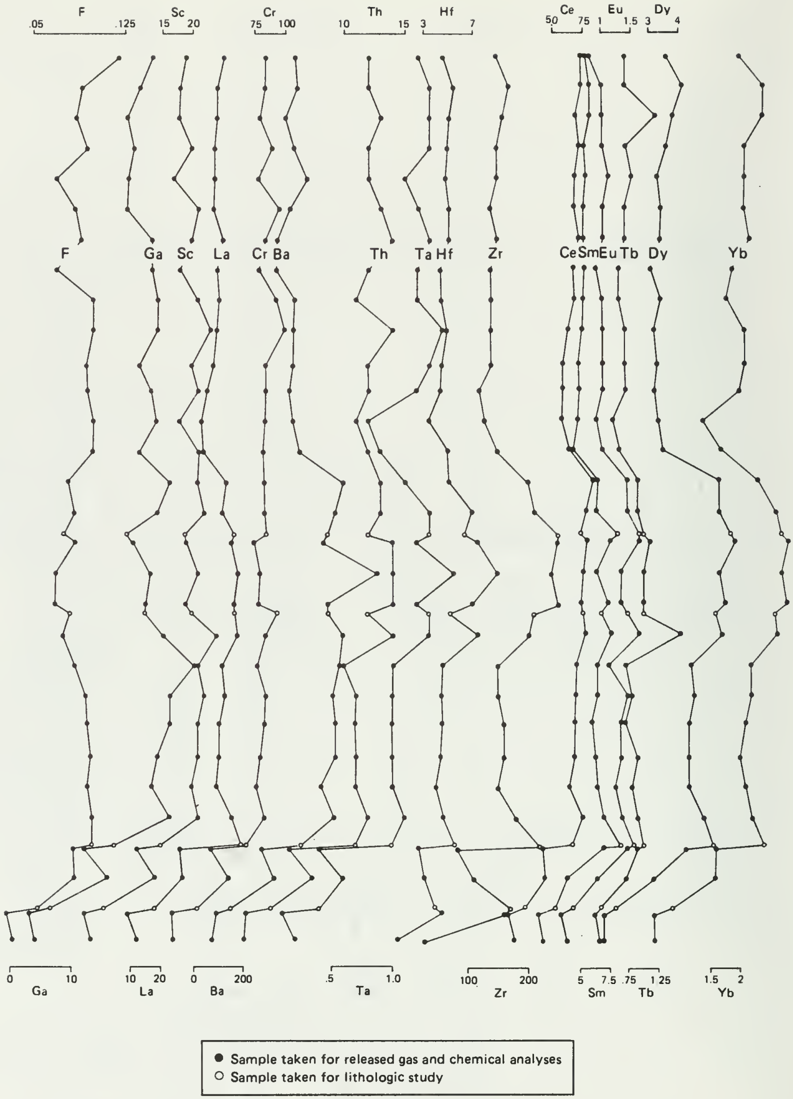


Figure 5. Core 041L continued

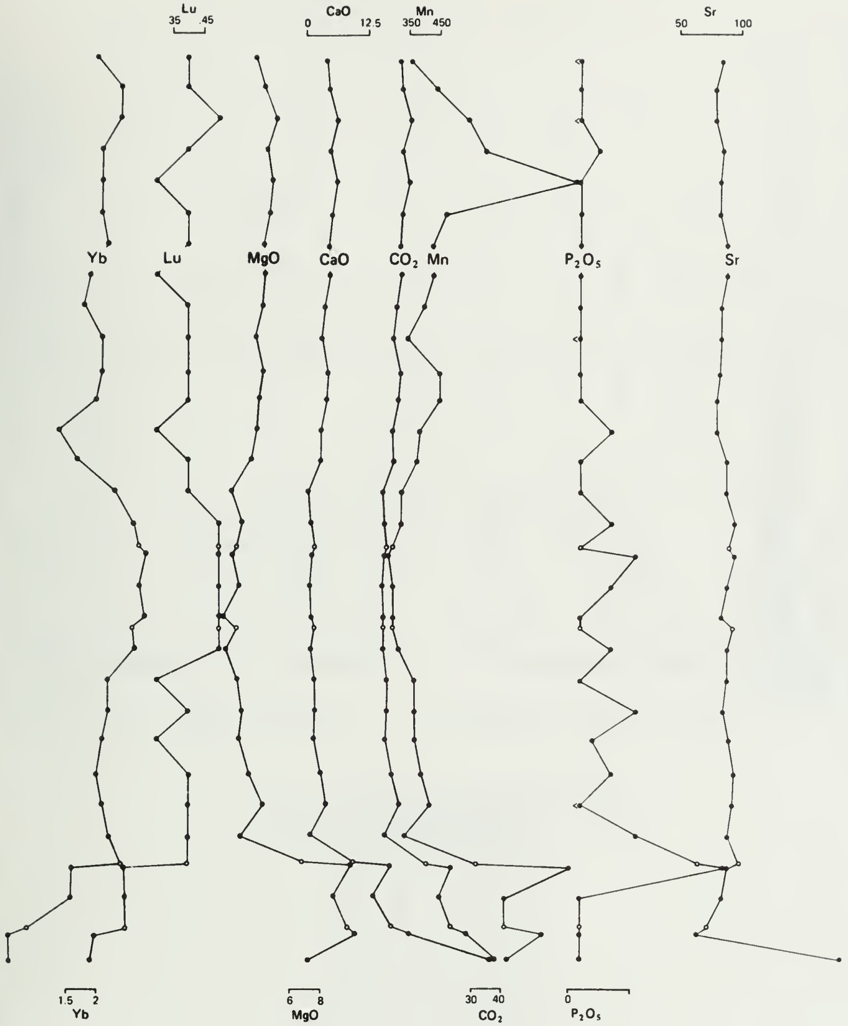
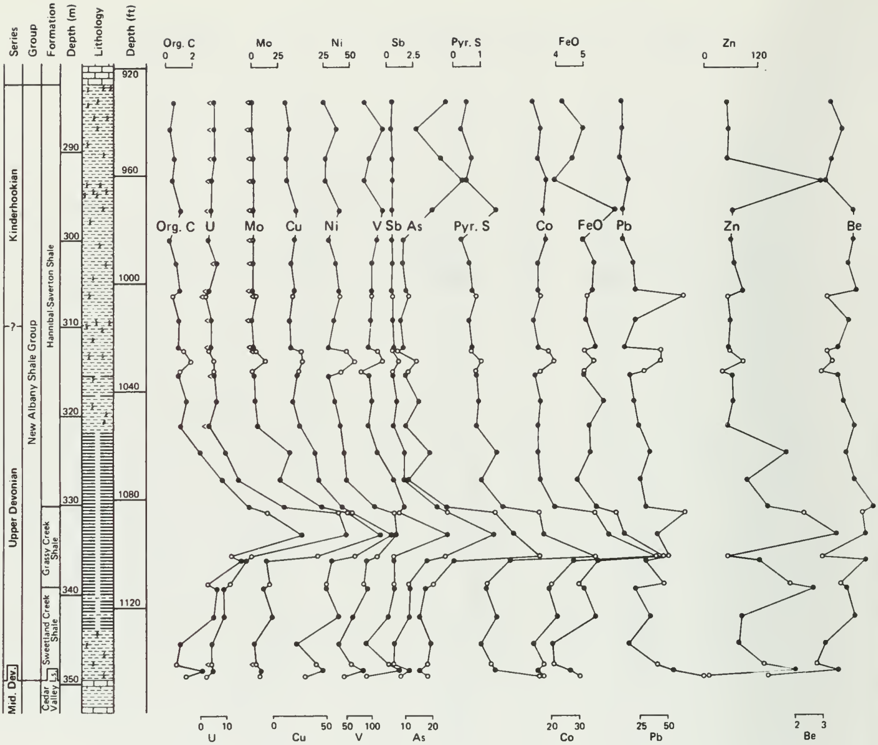


Figure 5. Core 041L continued



Concentration Unit			
%	ppm		
SiO_2	Be	As	Sm
Al_2O_3	B	Se	Eu
FeO	Sc	Rb	Tb
MgO	V	Sr	Dy
CaO	Cr	Zr	Yb
Na_2O	Mn	Mo	Lu
K_2O	Co	Sb	Hf
TiO_2	Ni	Cs	Ta
P_2O_5	Cu	Ba	Pb
CO_2	Zn	La	Th
Org.C	Ga	Ce	U
F			
Pyr.S			

Figure 6. Lithology and distribution with depth of the concentrations of the elements in the Tazewell County, Ill. core (061L).

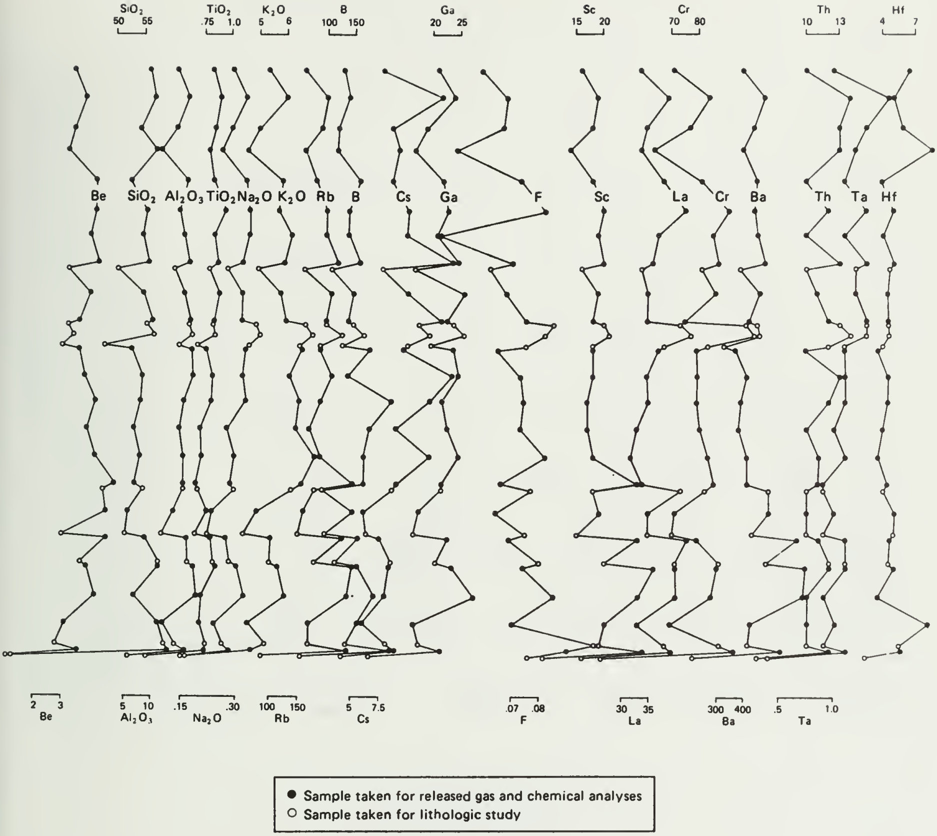


Figure 6. Core 061L continued

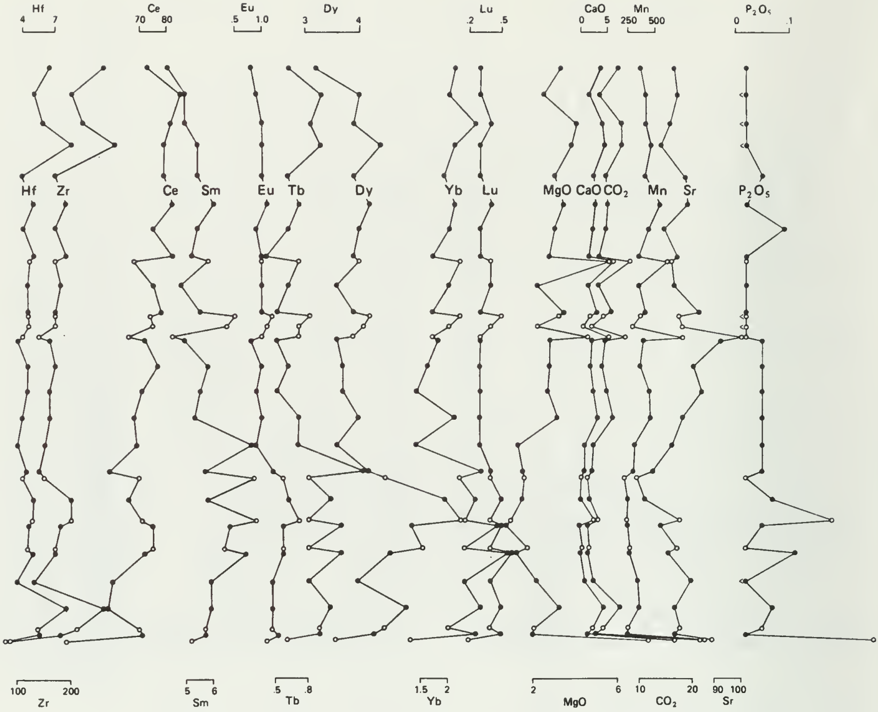
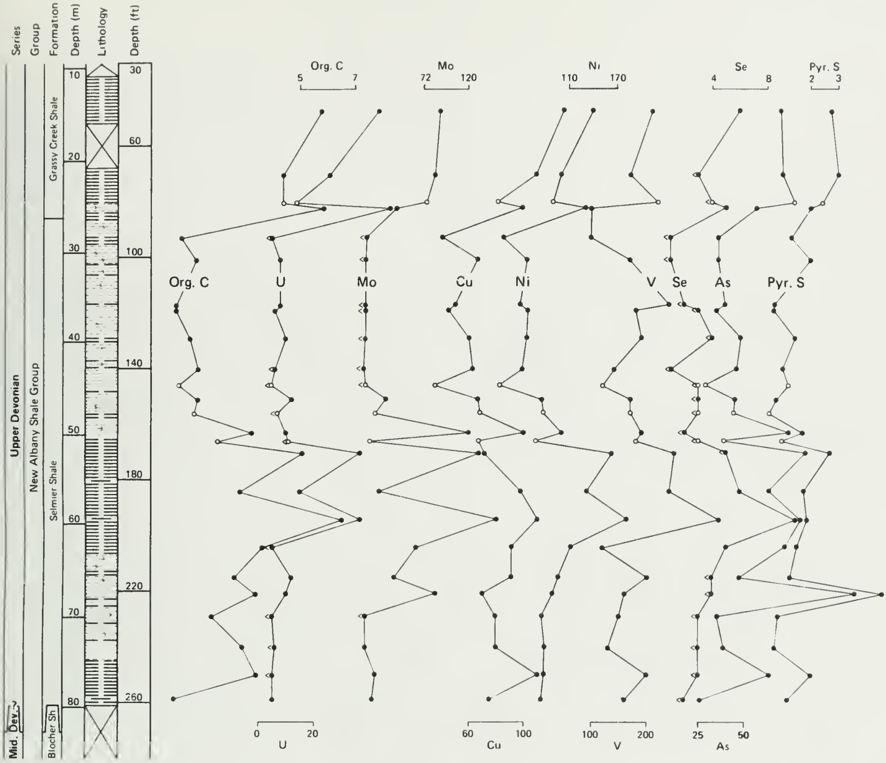


Figure 6. Core 061L continued



%	ppm		
SiO_2	Be	As	Sm
Al_2O_3	B	Se	Eu
FeO	Sc	Rb	Tb
MgO	V	Sr	Dy
CaO	Cr	Zr	Yb
Na_2O	Mn	Mo	Lu
K_2O	Co	Sb	Hf
TiO_2	Ni	Cs	Ta
P_2O_5	Cu	Ba	Pb
CO_2	Zn	La	Th
Org.C	Ga	Ce	U
F			
Pyr.S			

Table title: Concentration Unit

Figure 7. Lithology and distribution with depth of the concentrations of the elements in the Hardin County, Ill. core (11IL).

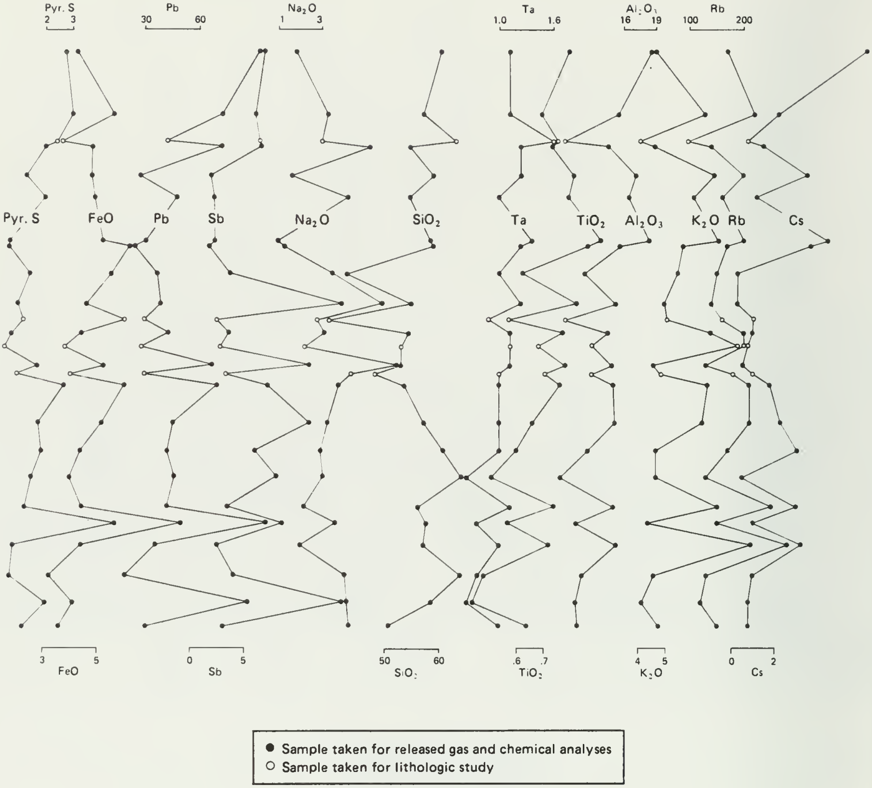


Figure 7. Core 111L continued

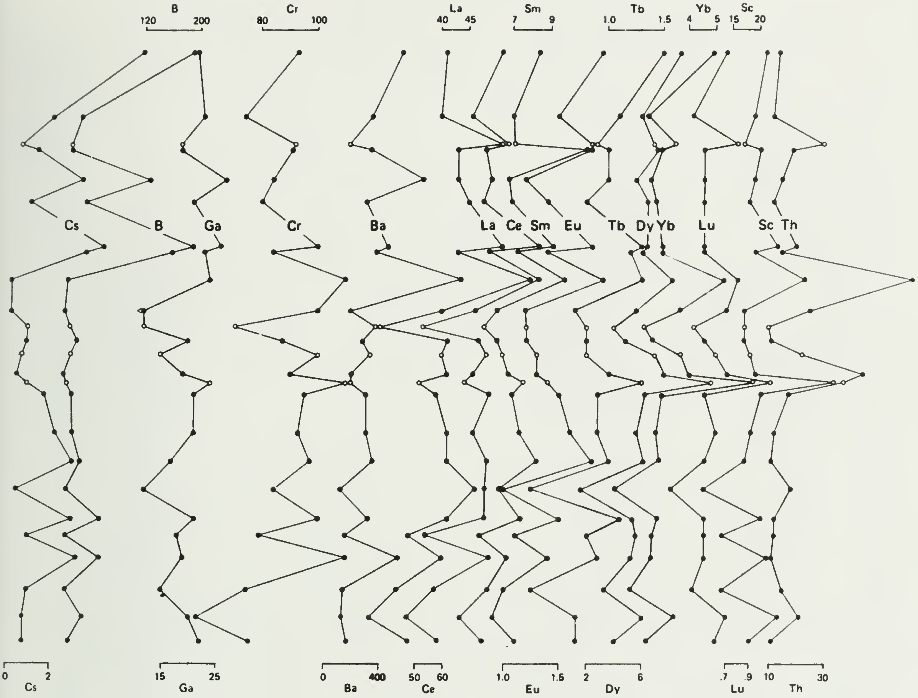


Figure 7. Core 111L continued

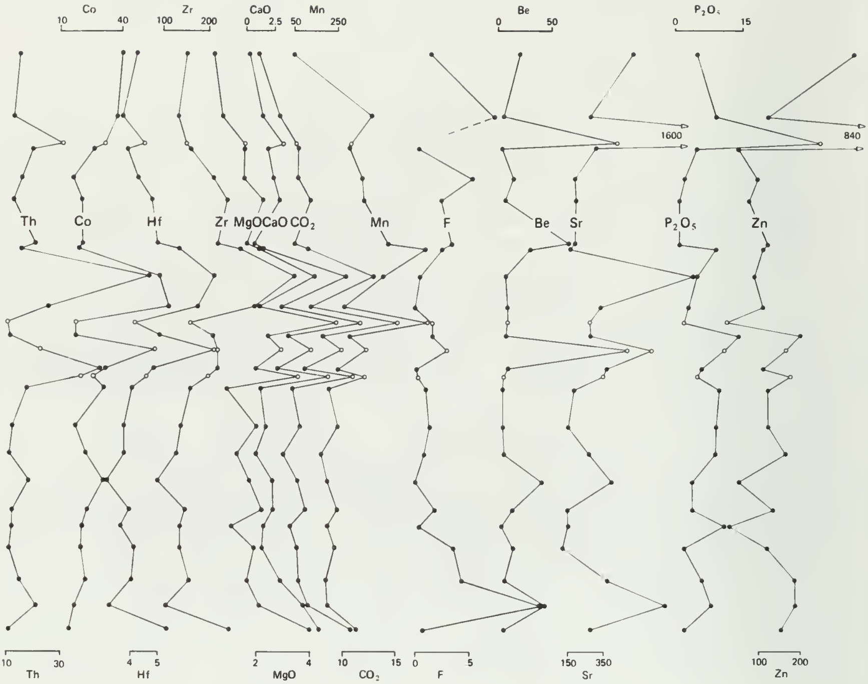
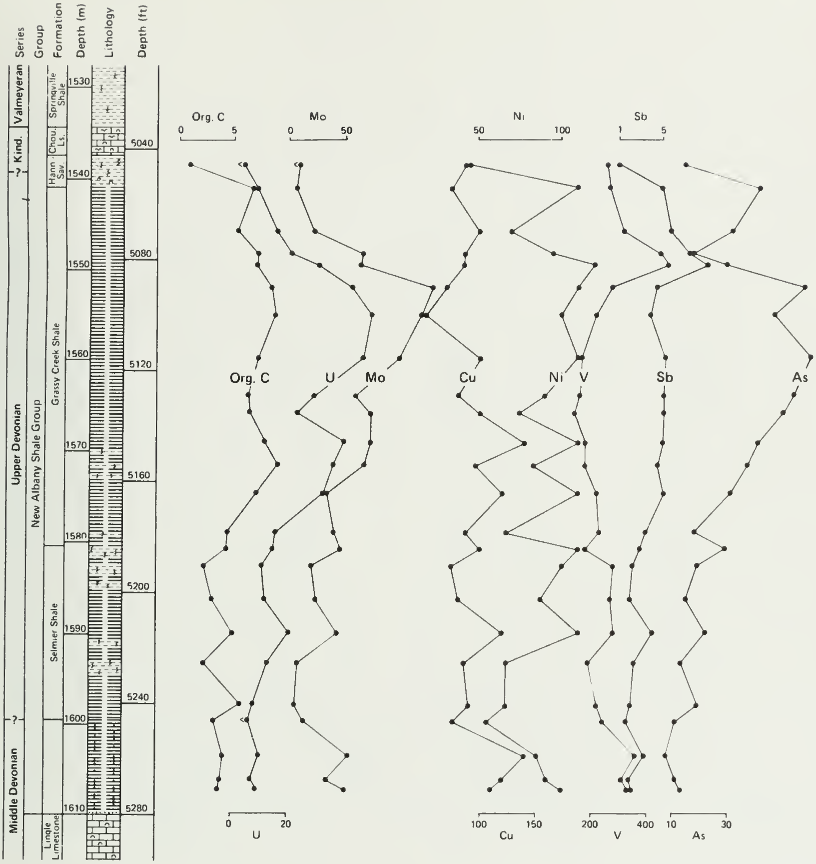


Figure 7. Core 11IL continued



Concentration Unit												
%				ppm								
SiO_2	CaO	P_2O_5	Pyr.S	Be	Cr	Cu	Se	Mo	La	Tb	Hf	U
Al_2O_3	Na_2O	CO_2		B	Mn	Zn	Rb	Sb	Ce	Dy	Ta	
FeO	K_2O	Org.C		Sc	Co	Ga	Sr	Cs	Sm	Yb	Pb	
MgO	TiO_2	F		V	Ni	As	Zr	Ba	Eu	Lu	Th	

Figure 8. Lithology and distribution with depth of the concentrations of the elements in the Wayne County, Ill. core (131L).

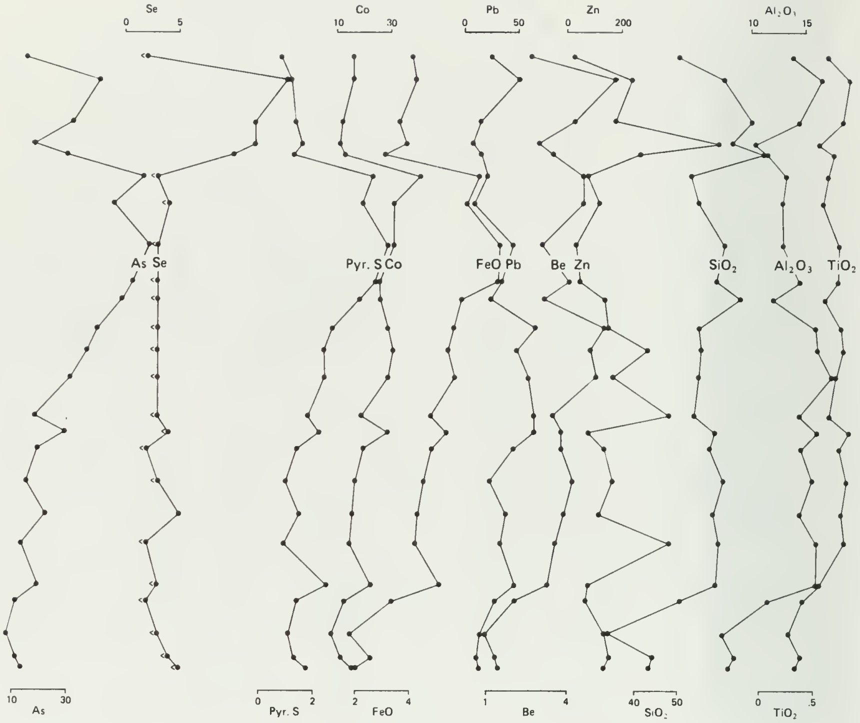


Figure 8. Core 131L continued

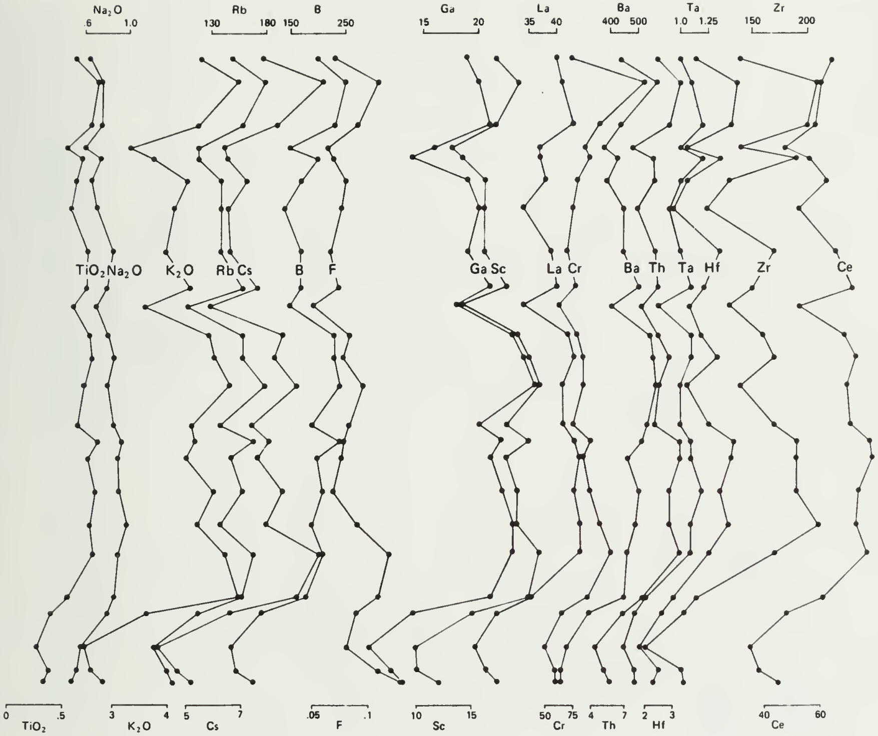


Figure 8. Core 131L continued

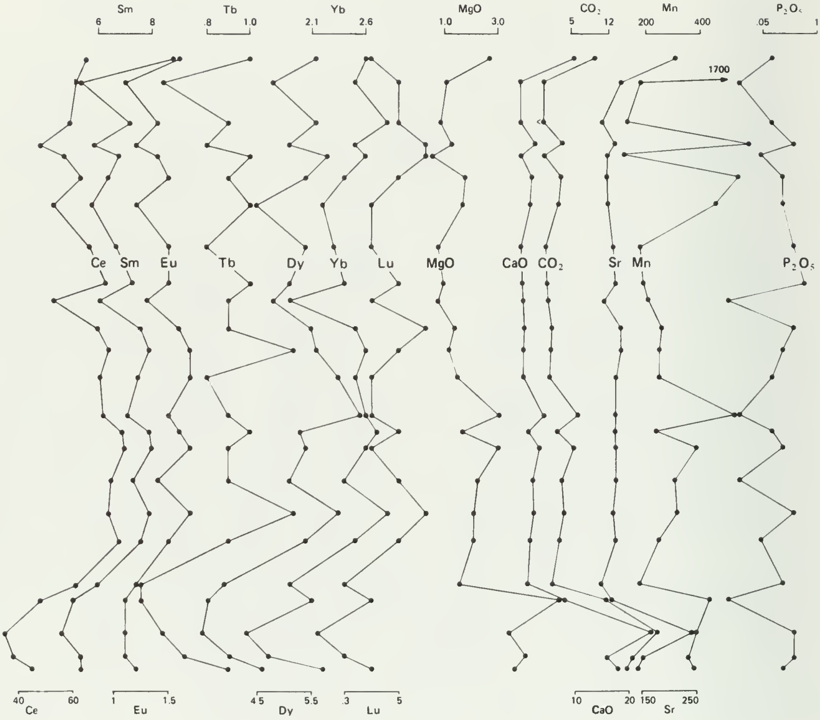


Figure 8. Core 131L continued

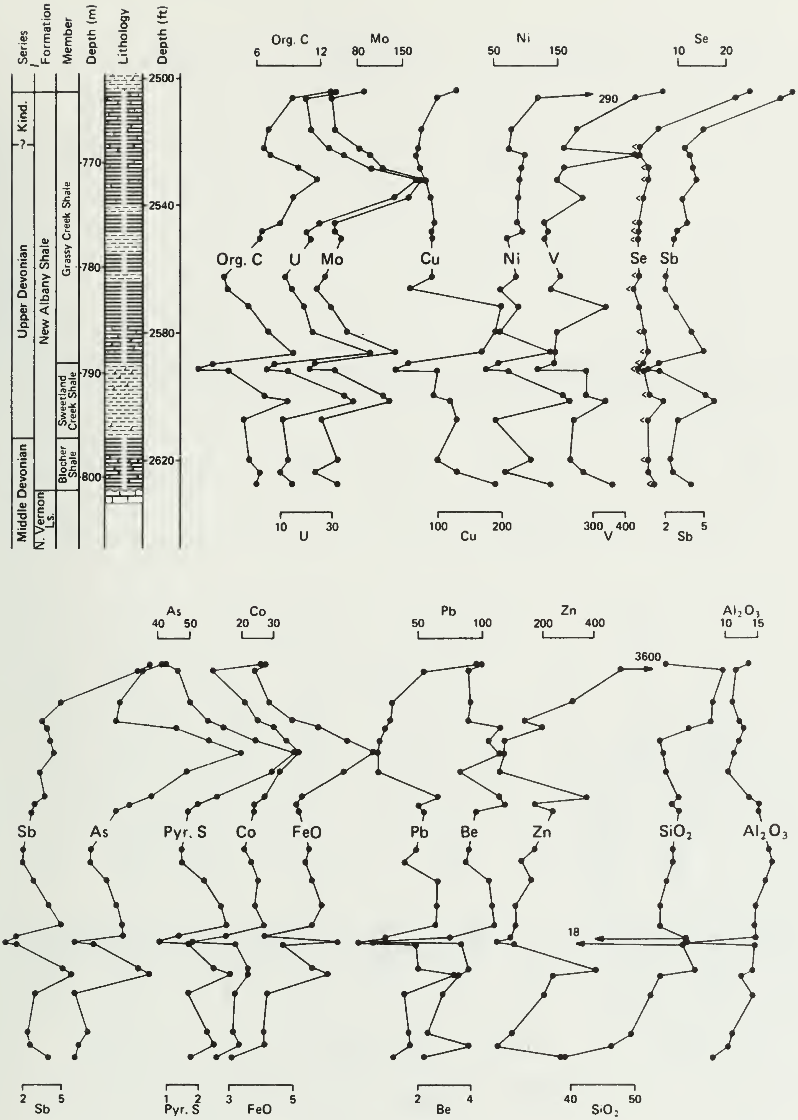


Figure 9. Lithology and distribution with depth of the concentrations of the elements in the Sullivan County, Ind. core (01IN).

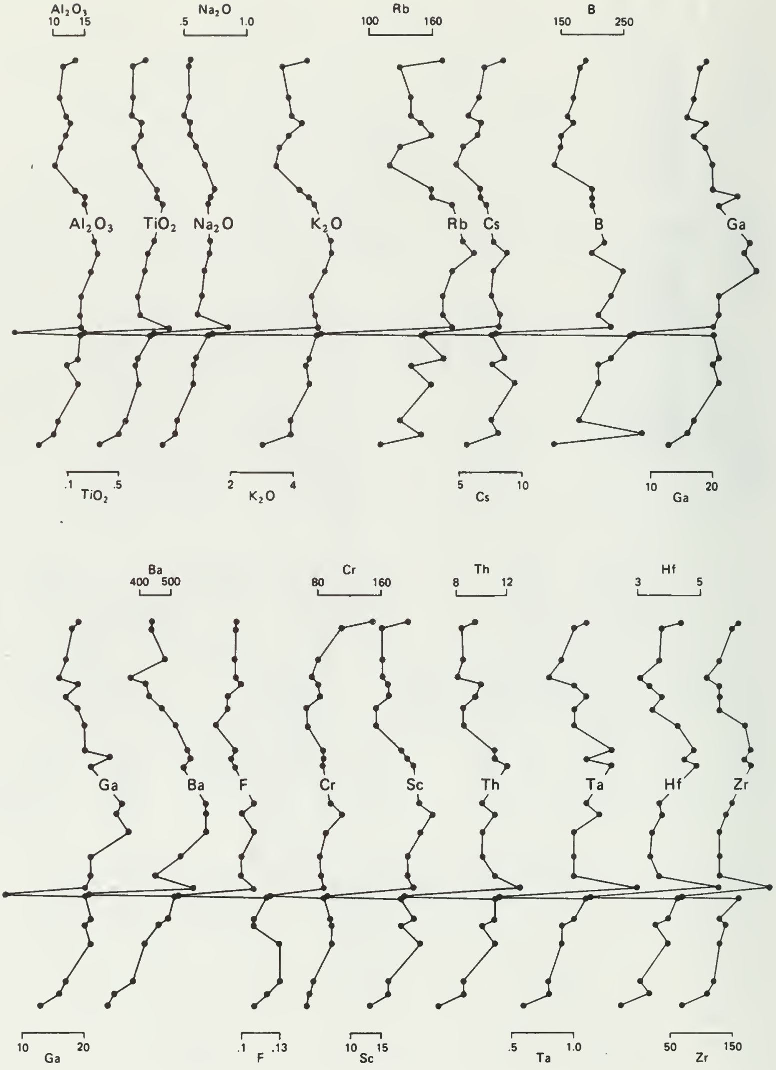
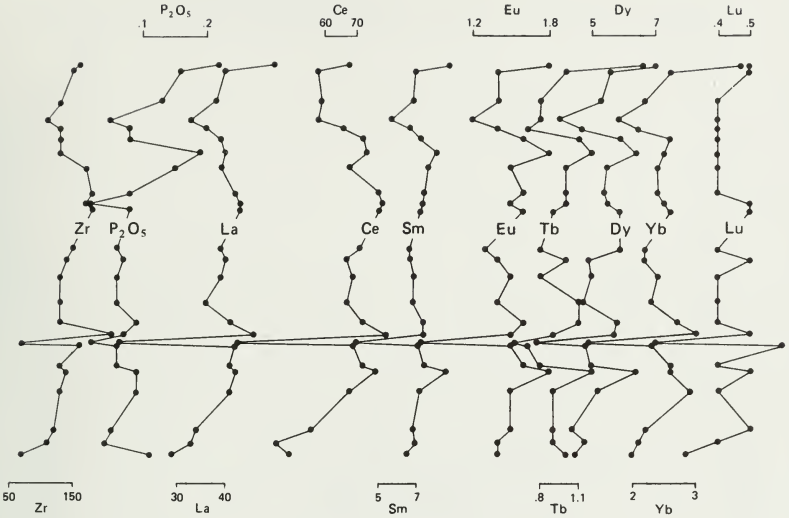
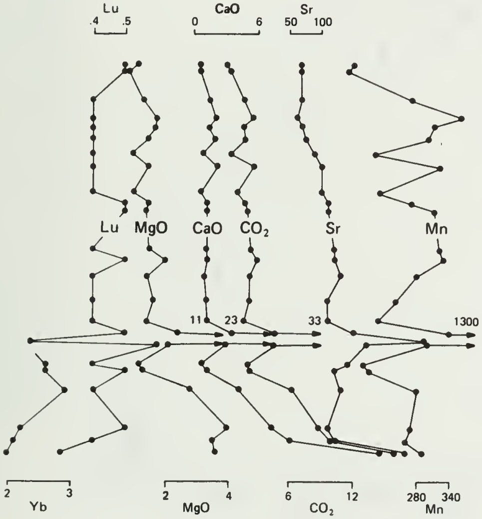


Figure 9. Core 01IN continued





Concentration Unit			
%	ppm		
SiO$_2$	Be	As	Sm
Al$_2$O$_3$	B	Se	Eu
FeO	Sc	Rb	Tb
MgO	V	Sr	Dy
CaO	Cr	Zr	Yb
Na$_2$O	Mn	Mo	Lu
K$_2$O	Co	Sb	Hf
TiO$_2$	Ni	Cs	Ta
P$_2$O$_5$	Cu	Ba	Pb
CO$_2$	Zn	La	Th
Org.C	Ga	Ce	U
F			
Pyr.S			

Figure 9. Core 01IN continued

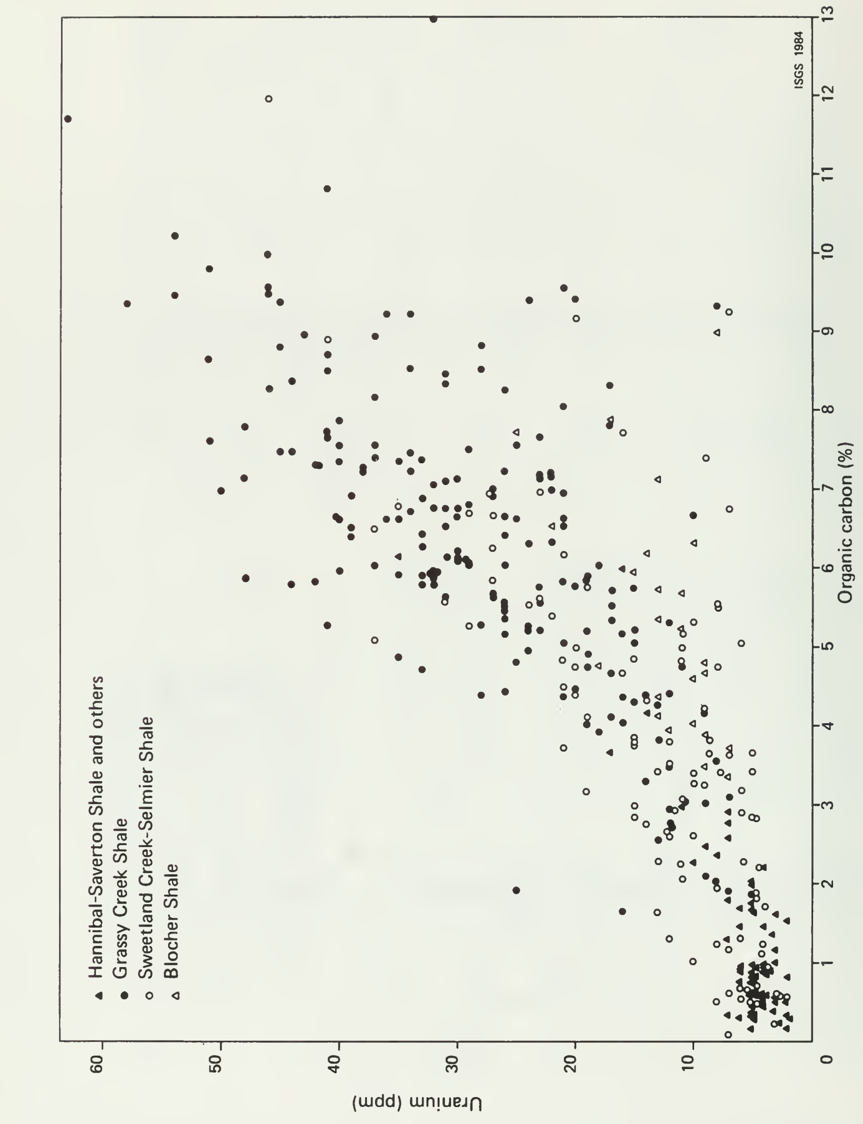


Figure 10. Distribution of uranium with organic carbon content in shales of the New Albany Group in the Illinois Basin.

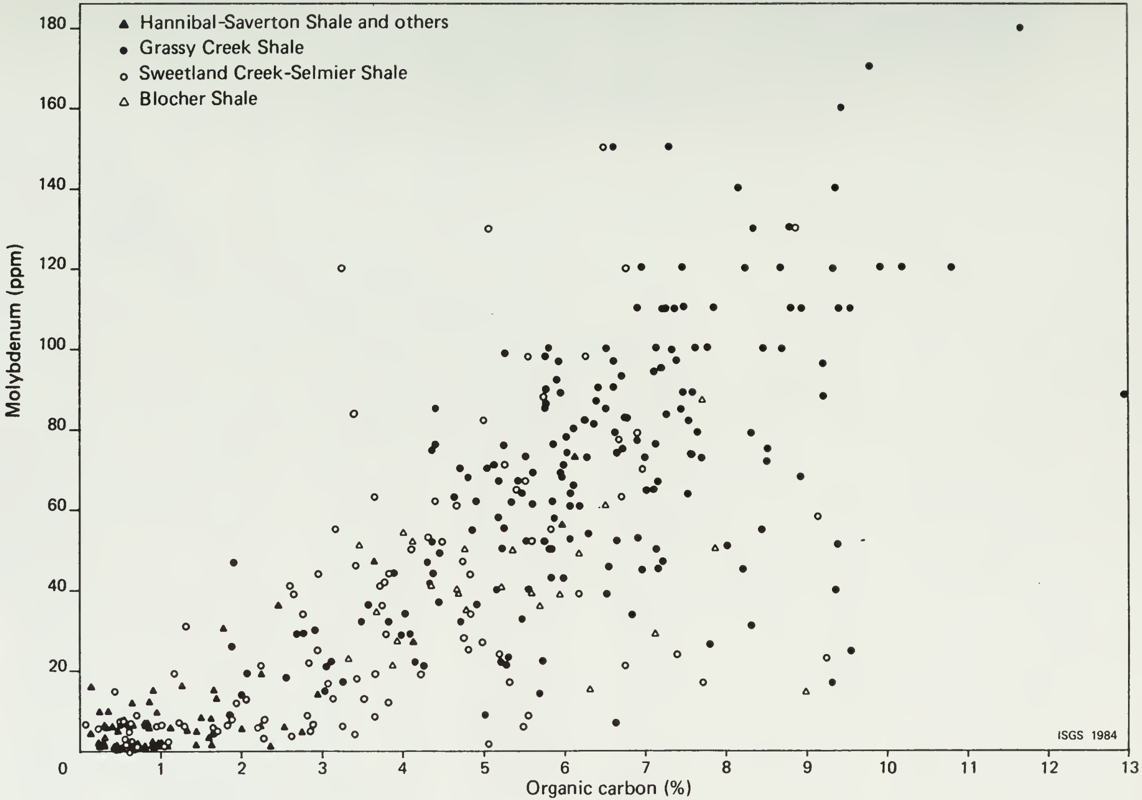


Figure 11. Distribution of molybdenum with organic carbon content in shales of the New Albany Group in the Illinois Basin.

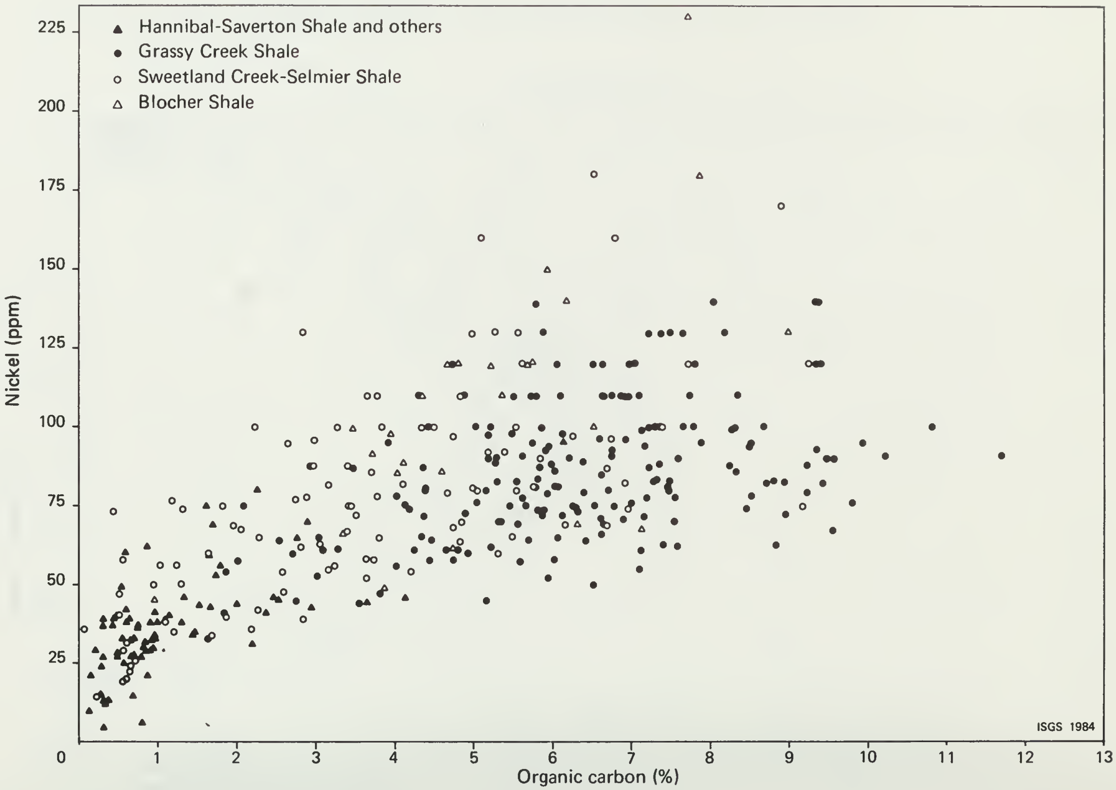


Figure 12. Distribution of nickel with organic carbon content in shales of the New Albany Group in the Illinois Basin.

Mineralogic studies (Harvey et al., 1980) showed chlorite to be widespread in shales of the New Albany, except in the Blocher.

Manganese correlated with MgO, CO_2, and CaO in the Sweetland Creek-Selmier Shale, but strontium did not--although strontium is often found widely distributed in carbonates. In the Hannibal-Saverton Shale both manganese and strontium correlated well with calcium and carbonate carbon; strontium correlated with calcium and carbonate carbon in the Blocher Shale, but manganese correlated only with magnesium (r = .63) in the Blocher. Compared to those in other shale units, the carbonates in the Blocher were the least efficient collectors of manganese and strontium, as demonstrated by the following mean concentrations for each unit:

370 ppm Mn, 85 ppm Sr, and 2.3% CO_2 in the Hannibal-Saverton;

290 ppm Mn, 92 ppm Sr, and 1.2% CO_2 in the Grassy Creek;

310 ppm Mn, 100 ppm Sr, and 2.8% CO_2 in the Sweetland Creek-Selmier;

340 ppm Mn, 140 ppm Sr, and 10.7% CO_2 in the Blocher.

In the Grassy Creek Shale manganese correlated best with calcium and carbonate carbon, but not well. Calcium in the Grassy Creek also showed a correlation with phosphorus, both occurring in apatite mineral grains; this occurrence diminishes the correlation of calcium with carbonate.

Organic and sulfide fraction. The main component of the organic or black shale fraction is, of course, organic carbon. It may not be necessary to consider a separate sulfide fraction because the organic and the sulfide fractions are related: the anaerobic and reducing conditions that led to the accumulation and preservation of the organic material in the shales also favored sedimentation of metal sulfides.

Following is a list of the elements that correlated best with organic carbon in each shale unit, in descending order of correlation:

Grassy Creek Shale: U (.74), Mo (.70), As (.56), Sb (.54), pyritic S (.49), Ni (.46);

Sweetland Creek-Selmier Shale: Ni (.77), Cu (.76), Sb (.73), pyritic S (.72), Mo (.68), U (.67), As (.59), Eu (.57), V (.54);

Hannibal-Saverton Shale: U (.88), Mo (.84), Sb (.83), Ni (.69), Cu (.64), V (.61), Sn (.60), Cr (.52);

Blocher Shale: Be (.73), B (.65), Cr (.60), Cu (.59), Ni (.58).

The Grassy Creek, Sweetland Creek-Selmier, and Hannibal-Saverton Shales are similar in that there are mutual correlations among organic C, U, Mo, Cu, Ni, V, As, Sb, Se, pyritic S, and Zn. Less well or only sometimes did FeO, Pb, Co, Ag, Cr, and Sn correlate in this organic fraction.

Iron is the element that correlated best with pyritic sulfur, a correlation that attests to the fact that a significant amount of the iron in these shales is present as pyrite. (An exception is in the Sweetland Creek-Selmier Shale where organic carbon and trace metals such as arsenic correlated better.) For example, the geometric mean pyrite content of the Blocher Shale calculated from pyritic sulfur data is 3.2%; this accounts for 68%, on average, of the iron in the Blocher. The calculated geometric mean of 4.1% pyrite in the Grassy Creek accounts for, on average, 48% of the iron in samples of that shale unit. Iron is also a constituent of such minerals as the clays and mica in sediments. The scatter plot of nonpyritic iron concentrations (calculated as the difference between determined total iron and the iron equivalent of determined pyritic sulfur, or total sulfur on the well cutting samples) versus alumina concentrations in the samples showed good correlation between them. Arsenic, cobalt and lead correlated well with iron and pyritic sulfur in the Grassy Creek and Sweetland Creek-Selmier Shales. It is well known that arsenic substitutes in pyrite (Goldschmidt, 1954), and enrichments of cobalt and lead are probably directly related to the amount of sulfide available to precipitate them as sulfides.

Elements with inconsistent correlations. Cobalt did not vary widely in the shales; most values were between 11 and 30 ppm, with a few higher values to a maximum of 59 ppm in the Grassy Creek Shale. Leung and Sanders (1973) reported 15 to 20 ppm cobalt for most of 21 New Albany Shale samples from Kentucky, but some had values as high as 70 ppm. In the Hannibal-Saverton Shale, which is low both in pyritic sulfur and in cobalt, the cobalt probably occurs as traces in clay minerals because it correlates with the alumina. In the Blocher Shale, which also contained no enrichment of cobalt, cobalt again correlated with the alumina.

Chromium levels were in the rather narrow range of 82 ± 20 ppm in 90% of the shale samples. Turekian and Wedepohl (1961) gave 90 ppm as the average concentration of chromium in shale, so it is concluded that the black shales of the Illinois Basin are not enriched in chromium. In the Blocher, chromium correlated very closely with Sc, Th, Rb, K_2O and other cations associated with clay minerals. In the Sweetland Creek-Selmier and Grassy Creek Shales, also, it correlated best with elements of the clay-mineral fraction. In the Hannibal-Saverton Shale one sample from core 07IL (Fayette County) containing 180 ppm chromium biased the correlation of chromium in favor of Se, Ni, V, Sb, Zn, and organic C, which were also high in that sample. Chromium would otherwise correlate with elements of the detrital fraction of the sediments. In 14 samples of Grassy Creek Shale and 2 samples of Selmier Shale from the deep southeastern part of the basin--each containing 5% to 13% organic carbon--chromium concentrations were 110 to 160 ppm. Vine and Tourtelot (1970) reported a median of 100 ppm chromium in several hundred black shale samples, but many samples ranged from 100 to 700 ppm chromium. Also, Leung and Sanders (1973) reported 45 to 60 ppm chromium for most of 21 samples of New Albany Shale from Kentucky, but some samples contained as much as 130 ppm. Thus, a mechanism does exist for concentrating of chromium in black shale deposits, probably by reduction of the chromates present in seawater (Goldschmidt, 1954).

The Blocher Shale was unique in that the elements correlating best with organic carbon were beryllium and boron; both elements also correlated well with potassium and scandium, which are associated with substitution into clay-mineral lattices. The Blocher Shale was enriched more than any other shale unit in copper, nickel, and vanadium. These three elements correlated to the extent of $r = .6$ with organic carbon. Other elements such as U, Mo, Zn, Sb, and Se are also concentrated in the Blocher Shale; they correlate mutually and with nickel, copper, and vanadium, but not with organic carbon or pyritic sulfur. These facts and the calcareous nature of the Blocher indicate a control on the deposition of this shale different from that of the other shales. Perhaps high reducing potential (low Eh) of anaerobic waters alone was important for the deposition of the Blocher Shale, with pyrite formation related to periodic influx of sulfidic waters or to post-depositional sulfidic waters.

The rare earth elements La, Ce, Sm, Eu, Tb, Dy, Yb and Lu always correlated well with each other, as expected. One should expect to find them in the detrital fraction, particularly in zirconium and hafnium minerals (Goldschmidt, 1954). In fact, they did correlate with zirconium and hafnium or with Th, Ta, Al_2O_3, and TiO_2 in the Sweetland Creek-Selmier and Hannibal-Saverton Shales. In the Grassy Creek Shale, they correlated primarily with phosphorus, in a group with CaO, F, Ba, and Sr--probably apatite, which is also known to concentrate rare earth elements. One sample (S00005) in the Grassy Creek with $P_2O_5 = 4.25\%$ produced most of the correlation in this group of elements. When this sample was removed from the group to be analyzed, a correlation of lanthanum and cerium with thorium, titanium, and aluminum appeared, and the rare earth elements correlated as a group.

In mineralogic studies, Harvey et al. (1980) found these shales contained apatite in phosphatic fossil debris and in sedimentary nodules. Therefore, the likely mechanism for forming much of the apatite is reaction of solution with freshly precipitated calcium phosphate (displacement by F^-, OH^-, and Sr^{2+}) or replacement of precipitated calcium carbonate by reaction with dissolved phosphate from dead sea organisms. Also, some apatite in the shale can be detrital (Goldschmidt, 1954).

When the one high phosphorus sample was removed from the Grassy Creek sample set for correlation analysis, barium then at least correlated moderately well with the detrital fraction [$r(Ba, Al_2O_3) = .43$ and $r(Ba, Sc) = .43$]. Barium correlated highly with the aluminosilicate fraction [$r(Ba\text{-}Ga, -Al_2O_3, -Sc, -Rb, -K_2O) = .83$ to $.76$] in the Sweetland Creek-Selmier Shale, and with that fraction, although less well, in the Blocher and Hannibal-Saverton Shales. The ionic radius of barium is close to that of potassium, so one may expect to find trace barium in potassium minerals--illite, for example (Brownlow, 1979).

The only clearly indicated occurrence of fluorine in these shales is in fluorapatite, from the few Grassy Creek samples with high levels of calcium, phosphorus and fluorine. Otherwise, fluorine correlated best with Rb, Sc, and Cs ($r = .6$) in the Blocher; with K_2O, Cs, and Al_2O_3 ($r = .5$) in the Sweetland Creek-Selmier; and with K_2O, Co, Al_2O_3, Sc, and Ga ($r = .6$ to $.5$) in the Hannibal-Saverton Shale, indicating adsorption or exchange of F^- on clay minerals. Saether et al. (1981) reported that fluorine in samples of "oil shales" from the Green River Formation in the Piceance Basin, Colorado, was associated primarily with micaceous clay minerals, particularly illite, on the basis of X-ray diffraction analyses. Desborough, Pitman, and Huffman (1976) found from electron microprobe studies that fluorine resided in fluorite and cryolite in 10 samples of Green River "oil shales" from the Piceance Creek Basin, Colorado, and the Uinta Basin, Utah.

In the Hannibal-Saverton Shale, there is a good correlation between germanium and sulfate sulfur (r = .81) and among Na_2O, sulfate S, Cl, and Br, perhaps indicating the presence of simple germanium and sodium salts. Germanium, if it correlated at all in the other shale units, correlated with chlorine. Also, there was positive correlation among Na, sulfate S, Cl, and Br in the Grassy Creek Shale. In two-thirds of the samples, bromine levels were below the detection limit by neutron activation analysis. No concentration of bromine much greater than the average was found in any shale unit. Trends in concentration levels were not clear, therefore, and statistical analyses done on the small number of bromine values are of limited significance. Tin correlated with chlorine (r = .57) in the Sweetland Creek-Selmier Shale, but generally the residence of tin was not clear from correlation analyses. Although tin correlated with the organic carbon fraction in the Hannibal-Saverton Shale, a plot of the data showed that 5 of the 79 samples unduly influenced the result, and so this correlation is considered spurious.

It was assumed that boron in the shale would arise principally from interaction of the sediments with seawater (Goldschmidt, 1954), but that is not clear from the results. In the Blocher Shale, boron correlated well both with the major constituent, potassium, and with trace substituents such as Th, Be, Ce, Sc, Cs and Rb of the clay-mineral fraction. In Sweetland Creek-Selmier Shale, boron correlated well with sodium (r = .68), and moderately well with Cr, Cu, and Dy.

Hardin County Core (11IL): Elemental Concentrations and Correlation Analysis

The Hardin County core was taken on the flank of Hicks Dome, a cryptoexplosion structure in the northwestern part of the Illinois Fluorspar Mining District. Local surface mineralization (chiefly fluorspar and barite) occurs within the central portion of the dome, associated with breccia enclosed in and derived from Devonian limestone. A large, mineralized breccia body, which showed extreme mixing of fragments from various stratigraphic units and contained some igneous materials, was encountered at depth in drilling near the apex of the dome. The breccia body carried fluorite with minor amounts of barite, lead, zinc, beryllium, and rare earth elements.

As a result of the complex history of igneous intrusion, brecciation, and mineralization in the Hicks Dome area, the samples of Grassy Creek and Selmier Shales in the 11IL core differ greatly with respect to concentrations of certain elements from the rest of the Grassy Creek and Selmier Shale samples. Including the samples from the 11IL core with the rest of the samples of Grassy Creek and Selmier Shale would have masked some of the regular composition and strong inter-element correlations observed for those two shale units.

With regard to major element composition, samples from the Hardin County core have a significantly higher sodium content (3.1% mean concentration of Na_2O) (table 11) than do shales from other locations (0.5% mean concentration of Na_2O). This difference is explained by the presence of a sodium feldspar (Harvey et al. (1980) found plagioclase.), probably formed in association with the metamorphism that accompanied the formation of Hicks Dome. Fluorine content varies considerably in the core samples, ranging from 0.014% to 1.17%. Concentration values much above the mean content of 0.13% probably reflect the fluorite mineralization of the area. Also, all but one Hardin County core sample met the requirements for the presence of siderite: 1% to 2% CO_2 in excess of the CO_2 equivalent of the CaO plus MgO present, and sufficient iron. These data support the finding of siderite in some samples by X-ray diffraction analysis by Harvey et al. (1980), and suggest ferroan-dolomite in the rest of the samples.

Among the trace elements, boron and cesium concentrations are significantly lower in the shale samples from the Hardin County core. These two elements correlate most closely with one another ($r = 0.88$). The next highest correlations are those with aluminum, where $r(Cs, Al_2O_3) = .74$, and $r(B, Al_2O_3) = .70$, and with bound water, where $r(Cs, H_2O+) = .76$ and $r(B, H_2O+) = .85$. These associations are perhaps related to the moderate levels of hydrothermal alteration that are evident in the area. Beryllium and strontium concentrations average significantly higher in the Hardin County core than in shales from other areas of the basin, and the elements correlate with each other ($r = .64$) and with zinc [$r(Be, Zn) = .58$, $r(Sr, Zn) = .82$] and phosphorus [$r(Be, P_2O_5) = .52$, $r(Sr, P_2O_5) = .71$]. In addition to the beryllium mineralization encountered at depth in the Hicks Dome area, Baxter and Bradbury (1980) reported the presence of the mineral bertrandite in a mineralized shale breccia dike that is about three-eighths mile northwest of the location of the 11IL core. The occurrence of beryllium in the core, however, is not identified. The tungsten content was measurable (mean concentration 6 ppm) in samples of this core, and the concentration of thorium in several samples was up to 6 times higher than the average of 10 ppm in other Grassy Creek and Selmier Shale samples. The mean concentration of arsenic was significantly higher than the averages in other Grassy Creek and Selmier Shales. The concentrations of antimony and selenium were somewhat higher. Arsenic concentrations correlated with both pyritic sulfur content ($r = .84$) and organic carbon content ($r = .73$).

The black shale component in the Hardin County core was not unusual, although the mean organic carbon content of 2.0% was lower than that in Grassy Creek and Selmier Shales from neighboring counties. Elements correlating with organic carbon were U, Ni, Cu, Mo, Pb and pyritic S, as well as arsenic. It was mainly the detrital component of the shale that was altered by metamorphism or igneous intrusion in the locality. The silicon content of the samples did not correlate well with that of any other elements. Aluminum correlated well with titanium ($r = .78$), and also with cesium ($r = .74$) and boron ($r = .70$), but less well with the substituents gallium, rubidium, and potassium, with which it correlated well in every other sample set. The rare earth elements correlated best with each other. The next best correlations were with the other cationic substituents Sc, Th, Cr, and Ba.

The mutual correlations of magnesium, calcium, and carbonate carbon were very good ($r > .9$). Chlorine and manganese also correlated with this group.

Intrusive dikes, sills, and explosion breccias are common in southeastern Illinois and western Kentucky. The igneous rocks are commonly described as mica periodotites and lamprophyres. The so-called "igneous" breccias are generally a mixture of sedimentary and igneous fragments with a matrix of rock flour and carbonate constituents. These igneous breccias and associated Hicks Dome "crackle breccias" (composed entirely of locally derived sedimentary fragments) are generally enriched in minor elements characteristic of alkali rocks, such as Na, Ba, Be, Ce, Ga, Nb, Sb, Sc, Sr, V, Y, and Zr.

Sample S00378, which is from the dike at the same depth as sample S00377, contains high levels of these elements:

Ca, Mg, Mn, and carbonate carbon;
Sr, P, and the rare earth elements;
Th, Hf, Ta, W, Ti, Co, and Cr (some of the less soluble elements); and
As, Be, Ni, Sc, Zn, and S.

A petrographic examination of the dike material (Bradbury and Baxter, in preparation) revealed extensively altered rock and mineral fragments in a matrix of carbonate identified as dolomite by X-ray diffraction. Similarities to surface exposures of igneous breccias on Hicks Dome indicate that the dike is similar to an igneous breccia. High levels of strontium, phosphate, and most other elements in S00378 also characterize the other igneous breccias.

Distribution of Elements on the Basis of Depth in Cores

Studying the variation in concentration of elements within a core provides information that may not be available in a comparison of data from a stratigraphic unit. A core is a detailed record of sedimentation in one small area, whereas data from a whole stratigraphic unit sampled in many parts of the basin reflect averages of the factors important in defining a depositional environment.

Figures 2 to 9 show the distribution relative to depth of the concentrations of elements in the eight DOE-EGSP cores. Elements with similar distribution patterns are nested to emphasize the similar patterns. In figure 4, the plot for the 02IL core, several elements nest with organic carbon. For example, r(organic C, U) = .96 on 13 samples. There is also a similar pattern between such pairs as Co and FeO (r = .89), TiO_2 and Al_2O_3 (r = .97), and CaO and CO_2 (r = .998). Related elements often correlate more highly within cores than in samples representative of a stratigraphic unit, but it is not always so. For example, the correlation coefficient between organic carbon and uranium in the core from Christian County, Kentucky (01KY) is .71 (whether or not the atypical Blocher Shale is included). This is lower than r(organic C,U) for the Grassy Creek, the Sweetland Creek-Selmier, or the Hannibal-Saverton Shale units. Clearly, changes in the sedimentation at one location over a long period can produce as much variation in the occurrence of elements as change from one location to another.

The down-hole plots (fig. 6) for the Tazewell County core (06IL) illustrate well relationships between the elements of the organic or black shale fraction because the core has an orderly progression of organic carbon content. It is low in the Hannibal-Saverton Shale, increases to moderate at the Hannibal-Saverton and Grassy Creek interface, to high in the Grassy Creek, and decreases to moderate at greater depth in the Grassy Creek and Sweetland Creek Shales, and to low at the bottom of the Sweetland Creek Shale where calcite content increases (fig. 6). Those elements showing the same progression of concentrations as organic carbon are, in order of decreasing similarity to the organic carbon pattern: U, Mo, Sb, Cu, V, Ni, As, pyritic S, and Co. (The selenium distribution might be expected to resemble the patterns of Sb, As, and pyritic S, but its pattern was not established because values for selenium were below detection limits of 1 to 4 ppm in nearly all samples from the core.) The good correlation between organic carbon and cobalt for this core (r = .71) arises from the definite association of cobalt with pyritic sulfur [r(Co, pyritic S) = .87 for the 31 samples from the core and .99 for the 5 samples of Grassy Creek Shale in the core]. Chromium does not show enrichment related to sulfide or organic carbon; it has a relatively constant concentration throughout the core.

In the Tazewell County core and in the Henderson County core (04IL) (fig. 5), the only other core taken that has a thick layer of Hannibal-Saverton Shale, arsenic shows a unique variation. In both cores, arsenic averages 22-23 ppm in the upper half of the Hannibal-Saverton, then abruptly declines to 10 ppm and less in the middle and lower parts of the bed. This change does not appear to be related to sulfide content, which is relatively low in all the samples. It may be related to clay content; Tourtelot (1964) concluded that in shales containing insignificant amounts of pyrite, arsenic resides predominantly in the clay minerals.

Also worth noting in the plots of elemental concentration relative to depth in cores is the anomaly displayed by the sample at the top of the Grassy Creek Shale in the core from Sullivan County, Indiana (01IN) (fig. 9). It shows disproportionately higher enrichments of Zn, V, Se, probably Ag, and to a lesser extent, Sb and Cr, compared to enrichments of these elements (relative to organic carbon or pyritic sulfur) in samples lower in the Grassy Creek Shale (fig. 9). This phenomenon was also noted by researchers at the Indiana Geological Survey for this Sullivan County core (Lechler and Leininger, 1978). Higher concentrations of zinc and the heavy metals V, Ag, Cd, Cr, Cu, Mo, Ni and Pb were found at the top of the Clegg Creek Member (upper part of the Grassy Creek in Indiana) in cores from Marion, Brown, and Clark Counties in south-central Indiana (Lechler et al., 1979). In the cores from the latter three counties, unusual enrichment--greater than in the Clegg Creek Member of these cores or of the Sullivan County core--of vanadium (to 5200 ppm), zinc (to 17,000 ppm) and several other metals was found in a layer 1 or 2 inches thick at the top of the Henryville and Falling Run Beds (Lechler et al., 1979; Shaffer et al., 1981). These two beds are in the Hannibal Shale overlying and contiguous to the Clegg Creek Member. Hannibal Shale is not present at the site of the Sullivan County core, and study of the Hannibal in southeastern Illinois was neglected in favor of study of the Grassy Creek and lower beds.

In a study of the New Albany Shale in Kentucky, to determine regional and stratigraphic variations in the concentrations of the elements, Leung and Sanders (1973) analyzed more than 200 samples from 25 counties by X-ray fluorescence and also a smaller number of samples by neutron activation analysis. They found chromium, which ranged from 45 to 130 ppm, and to some degree vanadium, which ranged from 100 to 450 ppm, to be concentrated near the top of the stratigraphic section; calcium and manganese were more abundant lower in the New Albany. They found no sign of significant regional variations.

Areal Variation of Elemental Concentrations

Variation in elemental concentrations from one part of the Illinois Basin to another can be related to one or more of the main factors in the sedimentation process: weathering, transport, deposition, diagenesis, and lithification. For example, different sources of detrital material for the sediments in different areas may be important in explaining why the concentration of potassium in Grassy Creek Shale is generally higher in the samples from the northern third of the basin than in samples from the southern two-thirds of the basin in Illinois.

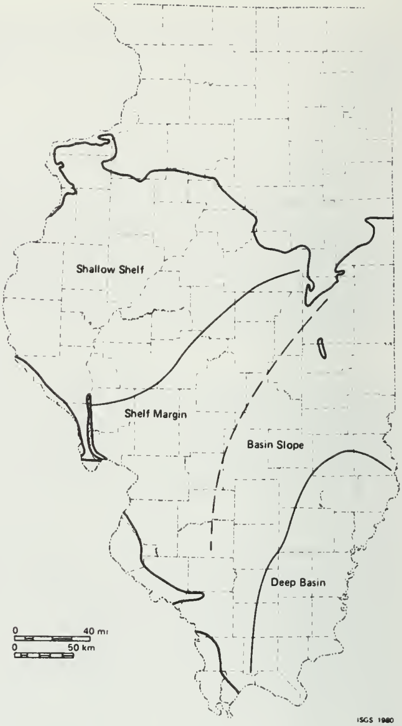


Figure 13. Paleogeography of the New Albany sea in Illinois. No sharp shelf margin-basin slope break has been identified, but facies relationships indicate that it was probably a zone north and west of the heavy dashed line. Reproduced from Cluff, Reinbold, and Lineback (1981).

Cluff, Reinbold, and Lineback (1981) described the depositional environment of the New Albany Group and the paleogeography of the New Albany sea, as shown in fig. 13, to which variation in the organic carbon content in these shales, as described by Frost (1980), can be related. The black Blocher Shale, which is confined to the deep basin of southeastern Illinois, is moderately high in organic carbon, averaging 4% to 9%; Cluff, Reinbold, and Lineback (1981) concluded that the deep basin was anaerobic during most of the New Albany deposition. Overlying the Blocher, the Selmier and Sweetland Creek Shales deposited in the deep basin and northwestward onto the basin slope, shelf margin, and shelf vary from brownish black and grayish black to greenish gray and grayish green and contain an average of 2.5% to 6.5% organic carbon. The Grassy Creek Shale, brownish black to grayish black in southern Illinois and western Kentucky and grading northward to olive gray and grayish green, is highest in organic carbon content (samples generally average 4% to 9%). On the shallow shelf in the extreme northwest part of the basin, the Grassy Creek and Sweetland Creek Shales represented by samples from the Henderson County core (04IL) contain less organic carbon (1% to 4%). The Hannibal and Saverton Shales, represented mainly by samples from the shallow shelf and shelf margin areas of the basin, have relatively low organic carbon contents, averaging generally 1% to 2%.

A plot of inorganic carbon content (as CO_2) relative to location in the basin shows no trend in variation in the Grassy Creek or Sweetland Creek-Selmier Shales. Noticeable are the high carbonate concentrations in southeastern Illinois in the Blocher Shale.

A plot of total sulfur in the shale samples relative to location in the basin shows that sulfur in the Grassy Creek Shale is generally low (1% to 2%) in the northwestern part of the basin on the shallow shelf. Sulfur concentrations in the Grassy Creek Shale in shelf margin and basin slope areas vary considerably (1.5% to 3.5% in general) and average somewhat higher in the southeastern section or deep basin where more samples with higher sulfur content (4% to 5%) are encountered.

Unusual Levels of Enrichment for Trace Metals in Shales in the Deep Basin

Figure 14 shows the geographical variation in selenium content in the core and well cutting samples of Grassy Creek Shale that were analyzed. In all areas outside the deep basin, selenium generally could not be quantitatively determined; concentrations were reported as less than the detection limit of 1 to 5 ppm. In some samples in the deep basin, including samples from the Sullivan County, Indiana core (01IN), values were significantly above the detection limit. This also occurred in the Selmier and Blocher Shales where only samples from the deep basin had selenium values significantly above the detection limit. Moreover, the selenium concentration in these samples from the various shale units correlated well with antimony content.

The plot of zinc in the shale samples relative to location showed random variation throughout the basin. Samples with the highest zinc concentrations were mostly from the deep basin; in fact, these were the same deep-basin samples with significant concentrations of selenium. Statistically there was good correlation of zinc and selenium concentrations in these samples.

This phenomenon also applies to vanadium. The plot of vanadium versus organic carbon concentrations showed that for most of the samples with moderate-to-high amounts of organic carbon there was a slight enrichment in vanadium, to levels of 300 ppm or less, with increase in the organic carbon content. A few samples were much more enriched in vanadium, to as much as 600 ppm or more. These samples were all from the deep basin; and they were the same samples showing high concentrations of selenium, antimony and zinc. The pattern of vanadium variation also applied to silver.

Samples with unusual enrichment in metals did not have a greater enrichment in copper, nickel and arsenic. They had good organic carbon concentration (generally 5% to 9%); but concentrations of Se, Sb, V, Zn, and Ag did not correlate well with organic carbon or with sulfur. The samples were generally moderately low (1% to 2%) in sulfur content.

These samples came from locations scattered throughout the deep basin, but did not include all the locations sampled. They were identified in the short Wayne County, Illinois core (12IL); at the top of the long Wayne County, Illinois core (13IL); at the top of the Sullivan County, Indiana core (01IN); and in the top sample only (usually Grassy Creek) from locations providing two or more well cutting samples. A plot of the selenium concentrations in these samples on the geologic cross section shows that this greater enrichment occurs in the top 30 feet of the Grassy Creek Shale in the deep basin; however, not enough locations were sampled to be able to state that the enriched layer is continuous. (Also, plotting on the cross section shows that the highest selenium concentrations in the Blocher are in the bottom 15 to 20 feet of the Blocher Shale.) This excess enrichment must relate to a depositional environment with narrow characteristics, specific to depth and time.

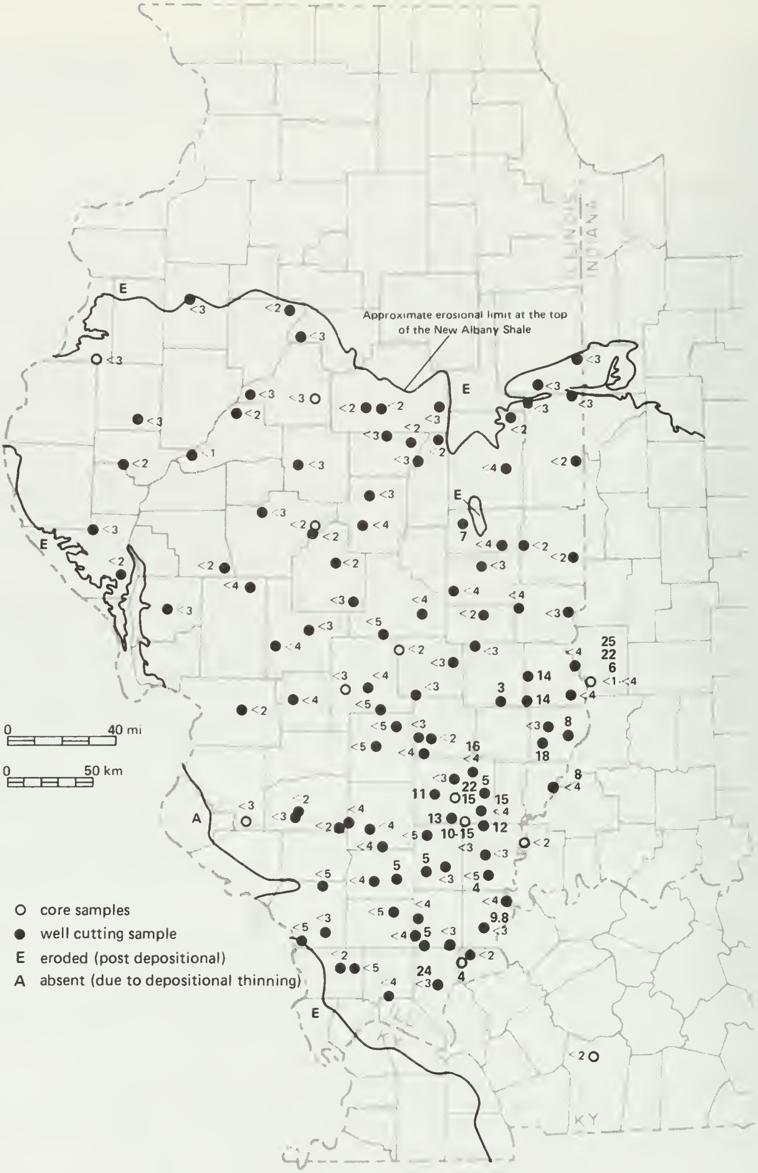


Figure 14. Selenium concentration (ppm) in samples from the Grassy Creek Shale. Detection limits were 1 to 5 ppm.

The elements enriched are chalcophilic (but do not include all the chalcophilic elements determined), but since they do not relate to sulfide content, perhaps, although iron sulfide is precipitated easily in a reducing environment, only within a certain range of oxidation-reduction conditions are certain trace elements incorporated. Rate of sedimentation may be an important factor as well.

Mode of Occurrence and Enrichment of Elements Concentrated in Black Shale

Uranium. The plot of uranium versus organic carbon content for shale samples from all parts of the basin (fig. 10) shows significant variation in the amount of enrichment of uranium in samples with a given organic carbon content. Other researchers have examined the reasons for such variation. Swanson (1960, 1961) discussed the types of organic matter, sapropelic and humic, in marine shales. He considered the humic type to be much more effective at sorbing uranium from solution and at inducing the reducing environment wherein tetravalent uranium is precipitated onto organic matter or clay material. Breger and Brown (1962) found that uranium correlated with organic content in their set of Chattanooga Shale samples. They concluded that whether organic carbon was terrestrial or marine was not important in the fixation of uranium.

From sulfur-isotope studies on Devonian black shales from the Appalachian Basin, Potter, Maynard, and Pryor (1980) concluded that rate of sedimentation was an important factor in explaining the relative concentrations of vanadium and nickel in their samples. They suggested, therefore, that much of the scatter in plots of uranium versus organic carbon content could also be explained by variation in rate of sedimentation.

Leventhal and Goldhaber (1977) studied samples from four Appalachian Basin cores and found that uranium content varied--although inconsistently--with organic carbon content, sulfur content, and change in lithology. Leventhal (1981a) further studied the organic material in black shales by gas chromatographic analysis of the products of their pyrolysis and identified a terrestrial vitrinite component and a marine-source organic component. He found that high uranium content related to the terrestrial organic component in his samples.

An attempt to explain the variation of uranium enrichment with organic carbon content in the Illinois Basin samples showed the following:

1) The scatter in the plot of uranium versus organic carbon in the samples from the cores is not explained by classification of the samples according to lithofacies.

2) The scatter in the plot of all samples that were reliably color-classified was not explained by color. Marine shales are black shales; and in the transition northwestward across the Illinois Basin from black to gray-black to dark gray to gray to greenish gray to olive shales, there is a general increase in terrestrial carbon content. Also, the scatter could not be explained by vitrinite reflectance values of the samples, which are a measure of the maturity of the organic material.

3) A plot of the areal distribution of a normalized uranium to organic carbon ratio of the samples (fig. 15) does not show a strong trend. The U/organic C ratio would be constant if the relationship between the two elements were a straight line through the origin. But it is a curve, as shown in the inset of figure 15, so that the value of the ratio is different at different positions along the curve. To avoid these differences in ratio that are the result of samples having different carbon content, the ratios were normalized. The experimental ratio for each sample was adjusted along the curve from the point that corresponded to the organic carbon content of the sample to the point corresponding to a median level of 6.0% organic carbon content. Thus, the U/organic C ratio for a sample was normalized by multiplying by 4.18/z, where 4.18 is the value of U/organic C on the correlation curve for an organic carbon content of 6.0%, and z is the value of U/organic C on the curve for the level of the organic carbon content of the sample. For example, a sample containing 50 ppm uranium and 10% organic carbon had a U/organic C ratio of 50 ppm x 10^4/10% = 5.0, which was normalized to 5.0 x 4.18/5.25 = 4.0. Now, differences in the normalized ratios plotted reflect only scatter about the correlation curve.

The normalized uranium to organic carbon ratio might have been expected to show a general decrease trending northwest to southeast in the basin, if terrestrial, as opposed to marine, carbon were the dominant factor in uranium enrichment. There are small areas, extending over two or three counties, where the ratio has a reasonably constant (within 0.5) low, intermediate, or high value, and here and there is a value anomalously low or high compared to many values around it. It is true that in a small area in the southeast, delineated in the figure, the ratio is relatively small for nearly all the samples. This area of the deep basin would be expected to have been rich in marine carbon. The uranium to organic carbon ratio is low for all Blocher samples: that is, uranium is less concentrated than average in the Blocher (fig. 10). The Blocher Shale, however, occurs only in the deep basin, so perhaps the deep sea marine carbon influence was a factor in determining that uranium was not concentrated as much in the Blocher and in the Sweetland Creek-Selmier and Grassy Creek Shales in some areas of the southeast part of the basin as it was westward in the basin. The higher carbonate content of the Blocher would also have been a factor in that unit--less clay minerals content to adsorb uranium.

Swanson (1961) in his extensive description of the occurrence of uranium and its geochemistry in marine black shales listed nine mechanisms of emplacement of uranium. It is difficult to investigate any one factor without controlling or identifying the effects of the others. Given the complexity of causes, we conclude that no single source of variation can be identified. Swanson (1961) concluded that most of the uranium in shales of the Chattanooga Shale type, which includes the Devonian Shale in the Illinois Basin, "probably was concentrated by direct precipitation by the action of hydrogen sulfide and by sorption of uranium onto solid and soluble organic matter of the humic type." It is reasonable to suppose that the dominant factor in the concentration of uranium in the Devonian shales of the Illinois Basin was the sedimentation process, including as parameters the rate of sedimentation, the height of the water column invaded by hydrogen sulfide, the circulation of the water, and the number of cycles of invasion and recession of a hydrogen sulfide-bearing layer.

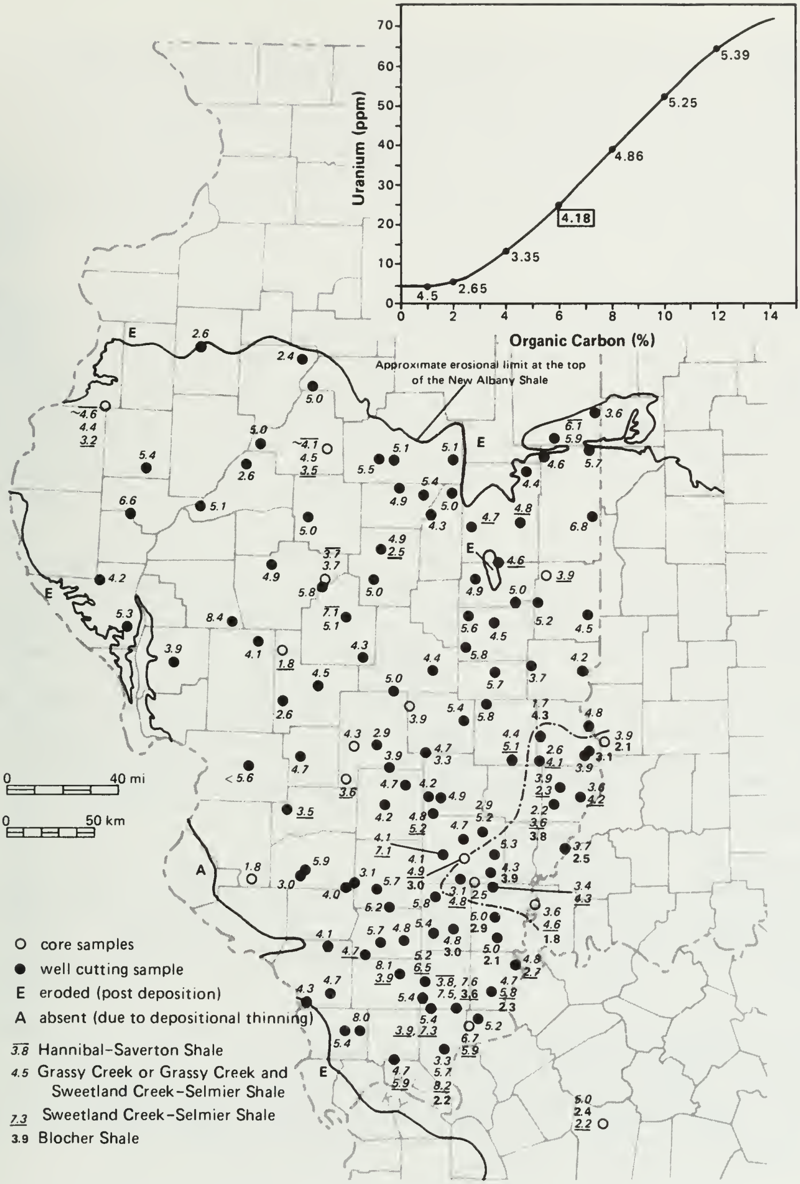


Figure 15. Variation of a normalized uranium to organic carbon content ratio (x10^4) in shales of the New Albany Group in the Illinois Basin.

Molybdenum. Goldschmidt (1954) and later researchers, such as Brumsack (1980), concluded that molybdenum was present as the sulfide in black shales. On the other hand, Leventhal (1981b) has considered that since molybdenum, like uranium, correlated so well with organic carbon content in black shales, the molybdenum must be associated with the organic matter. In the Grassy Creek and Sweetland Creek-Selmier Shales, the correlation of molybdenum was as good with pyritic sulfur as with organic carbon ($r = .7$). In all shale units the best correlation of molybdenum was with uranium ($r = .75$ to $.92$), perhaps reflecting reducing conditions that reduced both uranyl and molybdate ions in seawater.

Sulfide, arsenic, antimony, and selenium. The correlation between arsenic and sulfur in the shales is demonstrated in figure 16. Most of the sulfur is in pyrite, and it is inferred from the strong correlation of arsenic with iron and pyritic sulfur that arsenic substitutes for sulfur to give arsenopyrite, FeAsS. Antimony and selenium appear also to occur in sulfides. Wedepohl (1978) reported that in minerals, antimony occurs with sulfur in complex polyanions, and selenium substitutes for sulfur in minor or larger amounts in many sulfide minerals, such as in solid solution in lead and zinc sulfides. It is known from float-sink studies with Illinois coals that selenium and antimony are concentrated in the pyritic fraction (Gluskoter et al., 1977).

In Sweetland Creek-Selmier Shale, there is high mutual correlation ($r = .71$ to $.88$) among As, Se, Sb, and S. This mutual association is not so apparent in the other shale units, particularly the association between selenium and the other three elements, because selenium was reliably determined in only a small number of samples. It was not determined in a significant number of Hannibal-Saverton Shale samples. In the Blocher Shale samples, Se, Sb, Zn, Ni, and V correlated well with each other ($r = .63$ to $.82$), but not with sulfur. In the Grassy Creek Shale, selenium was reliably measured in only a small number of samples from the deep basin. Here selenium correlated with Sb, Zn, V, and Ag, but none of these correlated with sulfur content of the samples. Iron sulfide was precipitated and pyrite formed throughout these shales, but apparently only sometimes were anaerobic conditions appropriate for the deposition of significant amounts of selenium, antimony, and some other chalcophilic elements as well.

Other metals. When concentrated in the shales, cobalt probably occurs as a sulfide with its deposition related to the formation of pyrite, since cobalt correlates with iron and pyritic sulfur, and arsenic. Since cobalt commonly substitutes in pyrite and is preferentially taken up in arsenides (Goldschmidt, 1954), (Fe,Co)AsS and even cobaltite, CoAsS, could be expected to occur.

Although sulfides of copper, nickel, and vanadium are undoubtedly present in the black shales, metallorganic complexes, particularly of vanadium and nickel, are known to be present in bituminous materials, and probably occur to some extent in these black shales. The fact that vanadium, nickel and copper are most concentrated in the Blocher Shale, which was less under the influence of high sulfide content during formation than was the more organic-rich Grassy Creek Shale, is evidence for this.

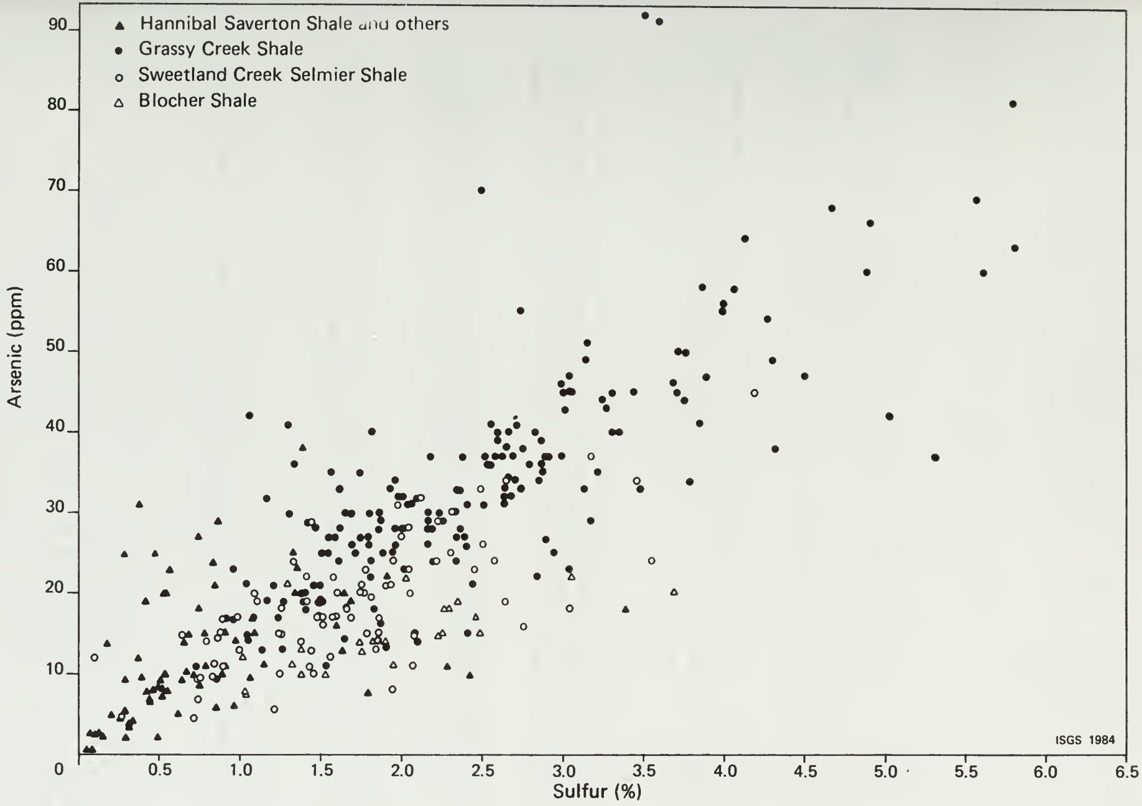


Figure 16. Distribution of arsenic with total sulfur content in shales of the New Albany Group in the Illinois Basin (except samples of the Hardin County core).

When concentrated in the shales, silver and lead probably occur as sulfides. Zinc precipitated in the black shales from seawater was probably deposited as sphalerite (Goldschmidt, 1954). Chromium did not appear to be concentrated to any degree from seawater into sediment in this basin. Instead, it displayed a rather uniform concentration in the shales, probably as chromites associated with the detrital clays.

SUMMARY

Blocher Shale, which occurs at the base of the New Albany Shale Group in southeastern Illinois, is a brownish black to grayish black shale. Organic carbon content averages generally 4% to 9%, with a geometric mean (all means in this section are geometric means) of 5.1% for the 24 samples analyzed. This shale is calcareous and dolomitic (10.1% mean CaO, 3.5% MgO, 10.7% CO_2). The trace element, manganese, correlated with magnesium content, and strontium correlated with the calcite components.

The trace elements that correlated best with organic carbon were beryllium ($r = .73$) and boron ($r = .65$). These two elements were not highly concentrated in this shale, however, compared to their concentrations in shales low in organic matter. Moreover, beryllium and boron also correlated with potassium, scandium and other elements belonging to the detrital clay minerals fraction.

Copper, nickel and vanadium concentrations were higher in the Blocher Shale than in the other shale units. Copper and nickel correlated moderately well with organic carbon ($r = .6$). The best correlation of copper, nickel and vanadium was with zinc, which was also strongly concentrated in the Blocher.

The Blocher was also enriched in pyritic S, As, Se, Mo, Ag, Sb, Pb, and U. The pyritic sulfur content of the analyzed samples was in the relatively narrow range of 1.0% to 2.5%. Arsenic and lead occurred in the pyrite. The highest selenium concentrations in the Blocher were in samples from the bottom 15 to 20 feet of the unit.

The prominent constituents of the detrital or clay minerals fraction, Al_2O_3, K_2O, TiO_2, and SiO_2, correlated mutually and include some iron. Trace elements correlating in this fraction were Rb, Cs, Sc, F, Cr, Ba, Ga, Th, Ta, Hf, Zr, Co, As (as well as in pyrite), and the rare earth elements.

Selmier Shale overlies the Blocher in southeastern Illinois, southwestern Indiana, and western Kentucky. Sweetland Creek Shale, which is for the most part stratigraphically younger, is in the central and western parts of the Illinois Basin. They are olive black to greenish gray shales, ranging generally from 2.5% to 6.5% organic carbon in the 79 samples studied (mean 3.2%). Sweetland Creek Shale in the far western part of the basin may be relatively poorer in organic material, as 14 samples from a Henderson County core averaged 1.7% organic carbon. In general, however, Sweetland Creek-Selmier Shale may be classified as moderately rich in organic material. It showed moderate enrichment of the following black shale indicators: pyritic S, V, Co, Cu, Ni, Zn, As, Se, Mo, Sb, Pb and U. Except cobalt and selenium, these elements correlated to some degree with organic carbon content, ranging from r(organic C, Zn) = .5 to r(organic C, Ni) = .77. Cobalt and selenium were shown by their correlations to be clearly part of a pyrite fraction that included arsenic as well as iron and pyritic sulfur.

Correlation analyses indicated that Ga, Rb, Cs, Sc, Ba, F, Be, B, Cr, Th, Ta, Hf, Zr, and the rare earth elements occurred principally in the detrital or clay minerals fraction with the major components Al_2O_3, SiO_2, K_2O, Fe_2O_3, and TiO_2. Thorium, Ta, Hf, Zr, and the rare earth elements correlated better with titanium than with aluminum.

Carbonate content of the Sweetland Creek-Selmier varied widely from 0.37% to 32.7% CO_2, but the geometric mean value was only 2.8% CO_2. Correlating as a group in the carbonate fraction were MgO, CaO, CO_2, and Mn, which suggests the occurrence of both calcite and dolomite, with trace substitution by manganese.

Grassy Creek Shale, which overlies the Selmier in southeastern Illinois and western Kentucky, is brownish black to grayish black. North and northwestward the Grassy Creek lies above the Sweetland Creek Shale (and sometimes interfingers laterally indistinguishably with it) and grades into olive black, olive gray, and grayish green shale. The Grassy Creek is the most organic-rich unit of the New Albany Group, ranging generally between 5% and 9% organic carbon in 185 samples, including 9 undifferentiated Grassy Creek-Sweetland Creek samples. The minimum organic carbon content was 1.64%; the maximum was 15.55%. (In the extreme northwestern part of the basin, however, the Grassy Creek is probably low in organic content; four samples from the Henderson County core averaged 2.8% organic carbon.)

The Grassy Creek Shale was also the unit of the New Albany showing the greatest enrichment of trace metals and black shale indicators: pyritic S, Co, Zn, As, Se, Mo, Sb, Pb and U. It showed high enrichment in V, Ni, and Cu as well. The geometric mean concentration of molybdenum in the samples studied was 60 ppm, with a range from 4 to 180 ppm. The mean for uranium was 26 ppm with a range from 5 to 75 ppm.

Among the samples was a group with unusually high enrichment of Se, V, Sb, Zn, and Ag. All these samples were from the top 30 feet of the Grassy Creek Shale in the deep basin of southeastern Illinois.

Correlating with K_2O, Al_2O_3, and TiO_2 in the detrital fraction of the shale were the trace elements Rb, Cs, Sc, Ga, Cr, La, Th, Ta, Hf, and Zr. Silicon did not correlate with this group in multiple regression analyses, a fact that indicated a variable quartz content in the Grassy Creek Shale.

The Grassy Creek Shale contains at least a small amount of calcite [r(CaO, CO_2) = .83]; the mean CO_2 concentration was 1.2%, and the range 0.11% to 6.30%. Magnesium did not correlate in the carbonate fraction, suggesting its occurrence was more important in the clay minerals. Manganese concentration correlated only with calcite, though not well.

The Grassy Creek did not have a high mean phosphorus content, only 0.07% P_2O_5, but the range of P_2O_5 was 0.01% to 4.25%, reflecting the finding from mineralogical studies that many samples of Grassy Creek Shale have detectable apatite. It was a Grassy Creek sample from the Christian County, Kentucky, core that contained the 4.25% P_2O_5. A well cutting sample (NAS-114) from Pope County, Illinois contained 1.74% P_2O_5; another (NAS-119) from Saline County, Illinois contained 0.41% P_2O_5. Calcium, F, Ba, Sr, and the rare earth elements other than lanthanum correlated with phosphorus in these high phosphate samples, which indicated the presence of apatite.

Saverton and Hannibal Shales, the topmost units of the New Albany Group, are generally greenish gray shales that are relatively low in organic carbon content. Sixty samples analyzed had a mean organic carbon content of 1%; most ranged from 0.5% to 2%. The Hannibal-Saverton was relatively low in pyritic sulfur also (mean value 0.6%). It showed little of the enrichment in trace metals commonly found in organic-rich shales, although U, Mo, Cu, Ni, V, and Sb did correlate with organic carbon.

The detrital fraction of the Hannibal-Saverton proved interesting: from correlation analyses there appeared two groups of detrital minerals. Correlating with the aluminum, potassium, and iron minerals group were Ga, Rb, Cs, Sc, Be, F, and Co. Correlating mutually in another group were sodium, silicon, and titanium, and the trace elements Zr, Hf, Ta, Th, Ba, La and Ce. Chromium is associated with both groups. A smaller and less important group of elements, Na_2O, Cl, Br, Ge and SO_4^{2-}, correlated mutually. This group indicated, perhaps, evaporite formation in the shallow shelf of the New Albany sea in the northwestern part of the basin.

The Hannibal-Saverton contained some calcite [$r(CaO, CO_2) = .95$]; the mean CO_2 content was 2.3% in 58 samples, and the range 0.02% to 18.58%. Manganese and strontium were identified with the calcite fraction.

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APPENDIX A

METHODS OF CHEMICAL ANALYSIS: DESCRIPTION

Wave-length Dispersive X-ray Fluorescence Analysis

Aluminum, Si, Fe, Ca, Mg, K, Ti, and P were determined by X-ray fluorescence, generally following the method of Rose, Adler, and Flanagan (1963). Samples and analyzed standards (0.125 g) were mixed with 0.125 g of lanthanum oxide and 1.000 g of lithium tetraborate, then fused in graphite crucibles at 1000°C for 15 minutes. The glass fusion bead was crushed and ground to -325 mesh, "Somar Mix" (Somar Laboratories, Inc., New York, NY) was added as a binder, and the mixture was pressed into a pellet at 40,000 psi. Addition of the heavy-element absorber lanthanum oxide simplified calibration and increased accuracy by eliminating many of the enhancement and absorption effects common to X-ray emission methods.

In the case of sulfur and chlorine, two or more grams (infinite thickness) of powdered whole shale or powdered standard were used in the analysis.

The instrument is a Philips Norelco vacuum spectrometer equipped with a Mark I electronics panel and a chromium target X-ray tube. Iron and titanium were determined with a lithium fluoride crystal in an air path. An ethylenediamine ditartrate crystal in vacuum was used in the determination of calcium, potassium, chlorine, and sulfur. Determinations of aluminum, silicon, and magnesium were made with a thallium acid phthalate crystal in vacuum; phosphorus was determined with a germanium crystal in vacuum. A background correction was made for each element.

Instrumental Neutron Activation Analysis

Weighed samples of about 0.3 g of shale were heat-sealed in cleaned two-fifths dram polyethylene snap-cap vials. Gamma activity of the samples was compared with that of a synthetic multielemental standard. The matrix of the standard was a weighed amount of about 0.3 g of a mixture of spectroscopically pure SiO_2, Al_2O_3 and Fe_2O_3 in the ratio 63:18:19 by weight. For analytes other than iron, aliquots of mixed standard solutions were made from a spectroscopically pure grade of each element or its compound and pipetted onto the base mixture contained in a polyethylene vial. The mixture was evaporated to dryness and the vial was sealed. The vials containing the samples and standards were enclosed in two-dram polyethylene vials; each set was irradiated in the Advanced TRIGA reactor at the University of Illinois in a flux of 1.4×10^{12} thermal neutrons cm^{-2} s^{-1}. The vials were contained in a rotary specimen assembly that rotated at 1 rpm during the irradiation to ensure that all containers had equal neutron flux. Two irradiations were made; the irradiation times, the decay interval, the count interval, and the nuclides observed are given in table A1.

Gamma ray counting was done on either of two coaxial Ge(Li) detectors: one a 75.7 cm^3 detector with measured resolution (FWHM) of 1.05 keV at 122 keV and 2.0 keV at 1332 keV, an efficiency of 17.6% and a peak/Compton of 48 at 1332 keV; and the other a 55 cm^3 detector with measured resolution (FWHM) of 1.10 keV at 122 keV and 1.9 keV at 1332 keV, a peak/Compton of 42 at the latter

TABLE A1. Data on isotopes and their measurement in the instrumental neutron activation analysis of shales.

	Element	Isotope produced	Half-life	Major gamma rays measured (keV)
Irradiation 10 min	Ba	^{139}Ba	1.38h	166
Decay 2h	Dy	^{165}Dy	2.32h	94.7,362,280
Δt count 2000-4000 s	Mn	^{56}Mn	2.58h	847,1811
	Sr	^{87m}Sr	2.83h	388
	Eu	^{152m1}Eu	9.3 h	122,963,842
	K	^{42}K	12.46h	1525
	Na	^{24}Na	15.0 h	1369
Irradiation 2h	Mn	^{56}Mn	2.58h	847,1811
Decay 24h	Eu	^{152m1}Eu	9.3 h	122,963,842
Δt count 6000-8000 s	K	^{42}K	12.46h	1525
	Zn	^{69m}Zn	13.9 h	439
	Ga	^{72}Ga	14.1 h	834,630
	Na	^{24}Na	15.0 h	1369
	W	^{187}W	23.9 h	480,686
	As	^{76}As	26.5 h	559,657,1216
	Br	^{82}Br	35.5 h	619,777,554
	La	^{140}La	40.2 h	1596,487,329
	Sm	^{153}Sm	46.9 h	103
	U	^{239}Np	56.4 h	228,278,117,106
	Sb	^{122}Sb	66.7 h	564
	Mo	^{99}Mo, ^{99m}Tc	67 h(eq)	140
	Yb	^{175}Yb	101 h	396,283
Irradiation 2h	Lu	^{177}Lu, ^{177m}Lu	222 h*	208
Decay 30 d	Nd	^{147}Nd	11.1 d	531
Δt count 40,000 s	Ba	^{131}Ba	12.0 d	216,496,373
	Rb	^{86}Rb	18.7 d	1077
	Th	^{233}Pa	27.0 d	312
	Cr	^{51}Cr	27.8 d	320
	Yb	^{169}Yb	32 d	177,198
	Ce	^{141}Ce	32.5 d	145
	Hf	^{181}Hf	42.5 d	482,133
	Fe	^{59}Fe	45.1 d	1099,1292,142.5
		^{54}Mn	303 d	835
	Sb	^{124}Sb	60.3 d	603,1691
	Sr	^{85}Sr	64 d	514
	Ni	^{58}Co	71.3 d	811
	Tb	^{160}Tb	72.1 d	879,1178
	Sc	^{46}Sc	83.8 d	889,1121
	Ta	^{182}Ta	115 d	1221,222,152,156,229
	Se	^{75}Se	120 d	265,401,136,280
	Zn	^{65}Zn	244 d	1116
	Cs	^{134}Cs	2.05y	796,605,569
	Co	^{60}Co	5.25y	1173,1332
	Eu	^{152}Eu	12.7 y	1408,779,1086

* The half-life value was calculated from the proportional contributions of ^{177}Lu and ^{177m}Lu existing at the end of the specific decay period used.

energy, and an efficiency of 14.5%. Each detector is connected via preamplifier, amplifier and live-time corrector and pulse pile-up rejector to a 4096-channel pulse height analyzer. In the latter half of the study, live time was measured with a pulser peak. Data from each analyzer are recorded onto a magnetic tape and the spectra are analyzed on the University of Illinois computer using a Fourier-transform smoothing program modified from Maney, Fasching, and Hopke (1977). Problems encountered in the gamma ray spectroscopic analysis of black shales have been discussed in Frost, Koszykowski, and Klemm (1982).

Optical Emission Spectroscopy

To avoid detrimental matrix effects caused by organic compounds, a portion of each shale sample was oven dried at 110°C and ashed at 500°C. The procedure was the same as that for the preparation of high-temperature coal ash described in Ruch, Gluskoter, and Shimp (1974). The ashed shale sample was cooled, weighed, and ground with agate mortar and pestle to a fine, homogeneous powder. Concentrations determined by spectroscopic analyses were calculated to values in unashed shale.

A set of synthetic standards was prepared for use in determining the trace element concentrations of shales. The synthetic standard matrix was prepared with the following composition: 64.53% SiO_2, 13.16% Al_2O_3, 6.03% $CaCO_3$, 6.18% K_2CO_3, 1.70% Na_2CO_3, 4.97% Fe_2O_3, 0.79% TiO_2, and 2.64% MgO. The concentrations of the major and minor elements for this average shale were the mean values of the concentrations in the set of first 32 shale samples that had been analyzed by X-ray fluorescence spectrometry.

To prepare standards containing 100, 33, 10, 3.3, and 1.0 ppm of trace elements, we added alumina and silica "Spex Time Saver Standards" (Spex Industries, Inc., Metuchen, NJ) containing 1000, 333, 100, and 33 parts per million of 49 different elements to the synthetic matrix in the same proportion (4.90:1, $SiO_2:Al_2O_3$) as its $SiO_2:Al_2O_3$ ratio. In the preparation of 1000- and 330-ppm standards, Spex Mix #1000, containing 1.27% of each of 49 elements, was used with silica and alumina in the appropriate ratio. The constituents of each standard and the weights used are given in table A2. To ensure homogeneity, we thoroughly ground each standard mixture with a mullite mortar and pestle under absolute ethanol.

Photographic Optical Emission Spectroscopy (OEP-1)

Forty mg of sample was mixed with 10 mg of spectroscopically pure barium nitrate and 150 mg of National brand SP-2X graphite in a polystyrene vial 0.5 inches in diameter and 1 inch in depth, containing two methacrylate balls 0.5 inches in diameter. The vial was agitated in a Wig-L-Bug mixer for 1 minute. Twenty mg of the mixture was taken for electrode charge. Analyses were made using the operating parameters given in table A3 for the elements listed in table A4. The emission lines listed in table A4 were those adopted for the bulk of the shale samples analyzed under OEP-1. (Some lines used in the early analyses proved to have interferences, and the elements were redetermined.)

TABLE A2. Composition of standards for spectroscopic analysis of shales.

	Standard no.						
	1	2	3	4	5	6	7
Wt of synthetic matrix (g)	0.90000	0.90000	0.90000	0.90000	0.90000	0.90000	0.90000
Concentration of trace elements in Spex Time Saver Standards (ppm)			1000	333	100	33.3	10.0
Wt of SiO_2 Spex Time Saver Standard (mg)			83	83	83	83	83
Wt of Al_2O_3 Spex Time Saver Standard (mg)			17	17	17	17	17
Wt of Spex #1000 Mix (mg)	79	26					
SiO_2 (mg)	17.4	62					
Al_2O_3 (mg)	3.6	12					
Concentration of trace elements in final standard (ppm)	1000	300	100	33	10	3.3	1.0

The percent transmittance values of the desired spectrographic lines on the developed photographic plates were determined by standard densitometry. Intensities were determined via Hurter-Driffield emulsion calibration curves. The data reduction steps are computer programmed by means of a spline function routine to fit the Hurter-Driffield curves with points spaced every 2 percent transmittance. The individual element working curves (intensity vs. concentration) are fitted by either first or second degree least-squares regressions or by combinations of the two types.

Direct-reading Optical Emission Spectroscopy

Electrode charges of 18 mg were taken from a mixture composed of 50 mg of shale ash mixed 1:3 by weight with a 2:1:1 by weight mixture of SP-2X graphite, sodium chloride, and potassium sulfate (spectroscopically pure salts from Spex Industries, Inc.) mixed well in a polystyrene vial as described for the photographic method.

Analyses were performed using the operating parameters given in table A3 for the elements listed in table A4. Concentrations were calculated from the intensity readings from the spectrometer as described in Gluskoter et al. (1977).

Photographic Optical Emission Spectroscopy (OEP-2)

In the middle of the New Albany Shales Group project, when shale samples numbered S00001 through S00205 had been analyzed by direct-reading optical

TABLE A3. Operating parameters for emission spectroscopy.

	Photographic (OEP-1)	Direct-reading	Photographic (OEP-2)
	Jarrell-Ash 3.4 m Ebert Spectrograph	Jarrell-Ash Model 750 Atomcounter	Jarrell-Ash 3.4 m Ebert Spectrograph
Grating angle			6.02° off normal
Arc current	14 amp	15 amp	17.5 amp (short circuit)
Arc voltage		~300 v	
Electrode gap	6 mm	6 mm	4 mm
Exposure time	65 sec	65 sec	40 sec
Sample electrode	National L-3903 crater electrode (ASTM No. S-13) 3/16 in. deep, 1/4 in. stock	National L-3979 crater electrode 1/4 in. deep, 1/8 in. stock	Ultra U-7 1086
Counter electrode	National L-4036 (ASTM No. C-1) 1/8 in. stock, pointed	National L-4036 (ASTM No. C-1) 1/8 in. stock, pointed	Ultra U-7 5001 1/8 in. stock, pointed
Electrode gap atmosphere and flow rate	80% argon, 20% oxygen at 14 SCFH	80% argon, 20% oxygen at 10 SCFH	80% argon, 20% oxygen at 14 SCFH
Electrode charge	20 mg	18 mg	40 mg
Entrance slit width	10 µm	10 µm	25 µm
Exit slit width		50 µm	
External optics	Intermediate aperture and crossed cylindrical relay lenses		Intermediate aperture and crossed cylindrical relay lenses
Step sector	6 step, 1:2 step ratio		4 step, 1:2 step ratio
Photographic emulsion	Eastman Kodak SA-1		Eastman Kodak 33
Photographic developer	Eastman Kodak D-19 5 min. @ 20°C		Eastman Kodak D-19 3 min. @ 20°C

TABLE A4. Elements determined by optical emission spectroscopy and emission lines detected.

Element	Wavelength (nm) Photographic (OEP-1)	Direct-reading	Photographic (OEP-2)
Be	313.1	234.9	313.1
B	--	249.8 (2nd order)	249.8
Cr	284.3	425.4	284.3
Co	345.4	345.4	345.4
Cu	327.4	327.4	327.4
Ge	265.1	265.1	265.1
Pb	368.3	--	283.3
Mn	280.1	--	304.4
Mo	--	317.0	317.0
Ni	349.3	341.5	341.5
Ag	338.2	--	338.2
Sr	--	460.7	346.4
Sn	303.4	303.4	303.4
V	311.8	318.4	311.8
Zn	334.5	213.9	334.5
Zr	339.2	339.2	339.2

emission spectroscopy, and samples numbered S00001 through S00238 had been analyzed by the photographic method, the work was abandoned because of the loss of all the optical emission spectroscopy staff. They were eventually replaced by new staff but continuity in this method of analysis was lost. Direct-reading optical emission spectroscopy was no longer used. Boron, molybdenum, and strontium, which had been determined by that method, were picked up by photographic optical emission spectroscopy. The following modifications were made to the photographic method to be used by the new optical emission spectroscopy group (OEP-2) to analyze shale samples numbered S00239 through S00430.

The instrumentation was upgraded by acquisition of a Baird Model RC-3 microphotometer. A Perkin-Elmer Model 53 strip chart recorder was connected to it. Also, a controlled arc-atmosphere semi-automated accessory device (Vogel, 1975) was attached to the arc stand of the spectrograph to provide reproducible plasma geometry and to reduce spectral interference from cyanogen.

The carrier and exposure conditions were modified to increase sensitivity for the elements. (For example, the concentration of silver in the shale samples was below the detection limit of 0.87 ppm 99% of the time, and no results for silver on samples S00001 through S00238 are included in the tabulated results.) The Eastman SA-1 emulsion was replaced with the lower-contrast type 33 emulsion to permit reducing the number of sector steps from six to four and maintain the equivalent dynamic range of spectral intensity; this gave a 67% increase in photographic plate capacity. A "plate standard" of a secondary reference material was exposed with each group of samples to minimize plate-to-plate bias.

In the new procedure, a 40-mg portion of the 500°C ash of a shale sample was mixed with 40 mg of SP-2X graphite powder and 10 mg of desiccated BaF_2 in a Wig-L-Bug mixer mill. Forty milligrams of this mixture were loaded into the sample electrode, and compressed and vented with a special tamp (a stepped rod with pointed end that exactly fits the electrode cavity) to obtain reproducible geometry of the electrode charge.

Emission spectra were recorded with instrument operating conditions listed in table A3. Transmittances were measured for spectral lines and background at line center for each analyte element as listed in table A4. Data on the transmittance measurements relating to emulsion calibration (for which a cubic spline function was employed) and to analytical curves and reference (plate) standards were processed using a computer program.

Energy-dispersive X-ray Fluorescence Analysis

Because there were problems in obtaining accurate results for zirconium by optical emission spectroscopy and for barium by instrumental neutron activation analysis, energy-dispersive X-ray fluorescence analysis was added to the New Albany Shales Group project for determination of zirconium, barium, cerium, and strontium.

The instrumentation consists of a Kevex Si(Li) detector with a resolution of 155 eV (FWHM) at 5.9 keV, a 300 mCi ^{241}Am excitation source, and a Tracor Northern 1700 multichannel analyzer.

The sample (1.000 g) was placed in a polyethylene cup which was then sealed with Mylar film 0.00015 inch in thickness. The cup was inverted and tapped so that the sample settled as a uniform layer on the Mylar. The sample was then placed in an alumimnum sample holder and exposed to monochromatic radiation generated from a secondary target of dysprosium for the determination of barium and cerium, and a secondary target of tin for the determination of strontium and zirconium.

Standards were USGS reference rocks and NBS Standard Reference Materials. Count rates obtained on samples and standards were corrected for background and a blank. For each element a plot was made of concentration relative to count rate for a set of standards with a range of concentrations of the element. The concentration of an element in a sample was then calculated as the product of net count rate for the sample and the slope of the curve of concentration relative to count rate for the standards.

Other Methods of Analysis

The procedures for the determination of total carbon and total hydrogen by a combustion method and for the determination of inorganic carbon by acid evolution were described fully in Frost (1980).

Fluorine was determined in the shale samples by ion-selective electrode analysis according to the procedure outlined by Thomas et al. (1977). The samples (100 mg) were fused with sodium hydroxide. The melt was acidified with sulfuric acid; a citrate-citric acid buffer that also complexes aluminium and iron was added. The fluoride potential was determined with a fluoride ion-selective electrode. An aliquot of a standard fluoride solution was added to the solution of sample, and the potential again measured. The fluoride ion concentration was determined from the change of potential.

Initially in the black shales project, sulfur was determined by wavelength-dispersive X-ray fluorescence analysis. The results were found to lack accuracy, however; and a standard gravimetric analysis (Furman, 1962), suitable for rocks containing appreciable pyrite, was then employed to determine sulfur.

A weighed sample of 2 to 5 g was treated with a solution of bromine in carbon tetrachloride. Concentrated nitric acid was added, and the mixture was simmered for an hour in a covered beaker, then heated to dryness. The sample was taken up in concentrated hydrochloric acid and again evaporated to dryness to expel all nitric acid. The sample was taken up in 10% hydrochloric acid, and excess aluminium dust was added to reduce iron to the ferrous state. The mixture was filtered; the filtrate was diluted with water and the acidity checked. Ten-percent barium chloride solution was added to precipitate sulfate as barium sulfate. The mixture was heated and digested overnight, then filtered. The barium-sulfate precipitate and filter paper were ashed at 800°C in a tared porcelain crucible, and the weight of barium sulfate was taken.

In a separate analysis, pyritic sulfur and sulfate sulfur were determined on the core samples. (Not enough sample was available to do this analysis on the well cutting samples.) The method was adapted from the ASTM (1977) standard method (D 2492) of test for forms of sulfur in coal.

To determine sulfate sulfur, the shale sample was refluxed with dilute hydrochloric acid in which sulfate sulfur dissolves. The mixture was filtered and the precipitate saved. Iron in the filtrate was oxidized with bromine, then the ferric iron was precipitated with ammonium hydroxide. The ferric hydroxide was removed by filtration. The filtrate was acidifed with hydrochloric acid, barium chloride solution was added, and the barium sulfate precipitate was separated by filtration, dried, and weighed.

The sample from which the sulfate had been removed by digestion with dilute hydrochloric acid was refluxed with concentrated nitric acid to dissolve pyrite; the undissolved material was separated by filtration. The pyritic iron in solution was separated by precipitation of ferric hydroxide with ammonium hydroxide. The precipitate was filtered off and redissolved in hydrochloric acid, and the iron in the solution was reduced to the ferrous state and titrated with potassium dichromate. The iron thus determined was then a measure of the pyritic sulfur. The average deviation of results for pyritic sulfur determined on duplicate samples was 0.05%.

It was our intention to calculate from the concentrations of total, pyritic, and sulfate sulfur a net organic sulfur concentration for each shale sample; however, the analyses were not accurate enough for this. An organic sulfur concentration calculated as the small difference between a large total sulfur value and a large pyritic sulfur value (plus a small amount of sulfate sulfur) had no certainty for use in studies of the constitution of the organic material in these shales.

Atomic absorption spectroscopy, with procedures as described in Gluskoter et al. (1977), was used in this project only as a referee method to obtain reliable values for Cu, Li, Ni, Zn, and Fe in a few shale samples and on the reference shale standards.

Exchangeable Cations (Ca, Na, K, and Mg) and Base-exchange Capacity of the Shales

These analyses were originally a task of the project. In initial work, the cation-exchange capacity of the shales was determined by the method of Peech et al. (1947). The shale sample was leached with ammonium acetate to remove exchangeable cations and to saturate the exchange complex with ammonia. Excess ammonia was removed by leaching with ethyl alcohol. The remaining exchangeable ammonia was removed by distillation and determined by titration with hydrochloric acid. The exchangeable cations calcium, magnesium, sodium, and potassium were determined on the original ammonium acetate leach solution by atomic absorption spectrophotometry. But the presence of calcium carbonate (and lesser amounts of magnesium carbonate) led to high values for exchangeable calcium (and magnesium) and to a low value for the total exchange capacity. Rather than continue the analyses with more complicated methods that would acccount for water-soluble carbonates, it was decided by the contracting agency that the performance of the task should be discontinued. This was reported in full in Bergstrom and Shimp (1978).

APPENDIX B

TABLE B1. Comparison of results of chemical analysis by the Indiana Geological Survey (A) (Lechler and Leininger, 1978) and the Illinois Geological Survey (B) on samples from the Pheghly No. 1 core, Sullivan County, Indiana (core 01IN). Each Survey split its samples from the core sections ground to -8 mesh, at different times.

Sample No.		Depth (ft) to top of sample	SiO_2 (%)		Al_2O_3 (%)		FeO* (%)		MgO (%)		CaO (%)		Na_2O (%)		K_2O (%)		TiO_2 (%)		P_2O_5 (%)	
A	B		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
P-8	S00352	2504.2	53.0	55.1	14.1	13.7	3.85	4.16	1.56	1.26	0.49	0.48	.55	.56	4.16	4.49	.81	.71	.24	.22
P-9	S00353	2505.9	60.7	63.8	12.1	11.7	3.59	3.84	1.31	0.88	0.59	0.52	.54	.54	3.67	3.74	.69	.62	.16	.16
P-10	S00354	2515.7	60.0	62.2	12.1	11.1	4.12	4.24	1.77	1.34	1.68	1.48	.53	.54	3.77	3.94	.67	.61	.15	.13
P-11	S00355	2521.5	59.6	61.6	12.2	12.1	4.32	4.97	1.93	1.74	1.99	2.02	.53	.50	3.93	4.04	.68	.59	.12	.05
P-12	S00356	2524.2	56.8	58.4	14.0	12.9	5.13	5.79	2.18	1.72	1.65	1.42	.59	.55	3.98	4.36	.72	.67	.12	.08
P-13	S00357	2528.2	53.8	53.9	13.2	12.2	5.63	6.67	2.12	1.53	1.97	1.84	.61	.55	3.64	3.92	.67	.66	.14	.08
P-15	S00358	2531.4	53.7	54.4	12.1	11.3	5.18	7.54	1.54	0.97	0.81	0.77	.59	.58	3.16	3.63	.62	.62	.17	.19
P-16	S00359	2536.9	57.6	54.9	12.2	10.4	6.85	6.59	2.04	1.50	2.29	2.09	.72	.67	3.55	3.51	.69	.66	.13	.15
P-17	S00360	2545.1	58.9	56.8	15.2	13.8	5.26	5.33	1.58	1.04	0.76	0.70	.79	.73	4.28	4.22	.81	.79	.13	.08
P-18	S00361	2547.5	56.4	56.1	15.5	15.2	4.95	5.13	1.89	1.48	1.08	1.05	.67	.71	4.56	4.56	.80	.80	.13	.02
P-19	S00362	2549.9	55.9	56.8	16.5	15.2	4.99	5.19	1.99	1.44	1.16	1.17	.74	.69	4.63	4.71	.85	.84	.11	.08
P-21	S00363	2561.8	55.6	56.0	18.5	16.8	5.28	5.48	2.13	1.51	1.08	1.05	.73	.71	5.23	5.21	.65	.77	.10	.06
P-22	S00364	2565.6	54.9	55.8	17.7	17.3	5.30	5.43	2.20	1.98	1.20	1.17	.67	.70	5.16	5.24	.79	.72	.11	.07
P-23	S00365	2571.5	54.6	55.0	17.7	16.1	5.63	5.64	1.93	1.44	0.97	0.88	.67	.67	4.98	5.06	.63	.70	.10	.06
P-26	S00366	2579.0	53.6	54.0	15.7	14.7	5.56	5.94	1.84	1.65	1.11	1.05	.63	.63	4.77	4.57	.60	.64	.08	.06
P-28	S00367	2585.6	52.2	54.2	14.1	14.6	5.86	5.57	1.77	1.45	1.20	1.09	.57	.61	4.55	4.70	.59	.67	.08	.09
P-29	S00368	2589.3	55.6	58.1	16.7	14.8	4.73	4.09	2.36	2.38	1.74	2.92	.69	.84	5.20	4.82	.84	.90	.10	.07
P-30	S00369	2590.7	17.8	17.9	4.61	4.19	6.55	6.41	9.84	10.75	23.0	23.2	.28	.26	1.54	1.44	.25	.22	.06	.02
P-31	S00370	2591.5	56.9	57.4	15.4	14.6	4.45	4.66	2.50	2.11	2.59	2.72	.69	.68	5.42	4.74	.65	.76	.08	.06
P-33	S00371	2598.8	56.1	58.9	14.7	14.1	5.62	5.59	1.65	1.21	0.84	0.73	.56	.58	4.96	4.52	.62	.65	.11	.06
P-34	S00372	2600.5	52.8	53.9	13.3	12.6	5.99	6.08	1.78	1.32	1.31	1.24	.56	.57	4.47	4.43	.63	.63	.13	.09
P-36	S00373	2606.3	51.3	52.4	13.8	14.1	4.12	4.20	3.15	2.81	3.93	4.16	.57	.57	2.94	4.55	.65	.66	.12	.09
P-39	S00374	2619.2	48.1	49.1	11.7	11.1	4.09	4.09	4.34	3.95	7.35	7.28	.45	.43	3.24	3.89	.54	.56	.11	.05
P-40	S00375	2622.8	47.6	46.5	11.0	10.4	4.02	4.10	3.50	3.54	8.35	8.94	.44	.42	3.80	3.90	.53	.50	.11	.04
P-42	S00376	2626.5	39.4	39.2	7.97	8.22	2.87	3.11	3.26	3.60	16.1	17.3	.42	.32	2.24	2.96	.39	.35	.10	.11

* Total iron.

TABLE B1. Continued.

Sample No.		S (%)		CO$_2$ (%)		C (%)		V (ppm)		Cr (ppm)		Mn (ppm)		Co (ppm)		Cu (ppm)		Zn (ppm)		Sr (ppm)		Th (ppm)	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
P-8	S00352	1.29	1.30	0.36	0.26	12.82	13.03	1250	520	143	150	140	160	28	26	130	130	3480	3600	68	70	8	9.5
P-9	S00353	1.57	1.57	0.68	0.54	9.32	9.53	919	430	107	110	140	150	4	11	114	99	317	510	74	68	10	8.3
P-10	S00354	1.99	1.86	1.99	1.87	7.51	7.69	271	250	71	81	265	270	21	21	72	75	199	320	78	72	9	8.5
P-11	S00355	2.27	2.34	2.39	2.66	7.32	7.51	191	210	66	72	295	360	49	25	67	69	137	130	78	64	9	8.1
P-12	S00356	3.08	2.99	2.33	1.93	7.70	7.88	169	430	75	81	285	310	67	30	63	67	214	200	80	72	9	9.7
P-13	S00357	4.28	4.00	2.44	2.02	10.19	10.49	172	210	70	83	285	300	63	34	75	72	46	56	82	75	9	9.4
P-15	S00358	5.12	4.91	0.75	0.64	11.73	11.86	189	190	58	66	180	200	84	38	100	79	46	51	91	89	9	8.5
P-16	S00359	4.42	4.30	2.73	2.77	10.02	10.22	152	270	57	67	300	320	72	32	70	88	43	35	100	100	8	8.6
P-17	S00360	2.64	2.65	1.09	1.23	7.79	8.58	163	150	71	86	195	210	48	27	100	95	272	370	120	100	11	11
P-18	S00361	2.06	2.03	1.67	1.83	6.32	7.08	166	160	79	87	240	270	50	24	81	91	124	170	127	110	11	11
P-19	S00362	1.78	1.80	2.05	2.14	6.10	6.89	149	150	78	86	265	310	60	24	70	92	175	240	110	110	7	12
P-21	S00363	1.60	1.49	2.21	2.52	3.49	3.62	170	200	94	96	285	320	45	21	69	91	119	170	133	120	11	10
P-22	S00364	1.51	1.48	2.81	3.11	3.77	4.13	168	170	88	110	295	330	37	23	77	57	114	120	140	120	11	11
P-23	S00365	2.30	2.22	2.50	2.40	5.67	5.84	177	340	84	90	250	280	52	25	106	200	116	160	131	130	11	10
P-26	S00366	2.72	2.90	2.46	2.39	7.37	7.77	169	190	77	82	215	240	54	24	111	190	117	97	125	110	11	9.9
P-28	S00367	3.50	3.18	2.68	1.94	9.86	9.90	191	180	71	83	195	210	58	27	116	170	136	98	114	110	10	11
P-29	S00368	1.50	1.43	5.12	4.56	3.04	3.26	138	180	77	88	355	340	22	15	56	56	96	80	164	150	13	13
P-30	S00369	0.74	0.80	31.5	32.7	9.20	9.41	54	130	29	28	1100	1300	14	4.3	15	36	50	25	268	260	2	3.8
P-31	S00370	1.59	1.78	3.92	4.54	4.24	4.65	168	280	80	87	265	300	39	18	89	100	97	93	161	170	11	11
P-33	S00371	2.66	2.65	2.15	2.23	7.22	7.38	320	280	83	95	165	180	33	22	97	96	288	410	146	140	10	11
P-34	S00372	3.39	3.18	2.88	2.41	9.28	9.54	420	340	84	97	170	190	38	22	171	120	245	240	131	120	11	10
P-36	S00373	1.93	1.73	5.99	6.34	6.49	6.56	209	240	82	97	255	280	38	18	134	130	147	210	130	130	11	11
P-39	S00374	2.31	2.29	8.99	8.79	7.83	7.74	139	230	61	74	255	270	22	17	108	100	70	82	122	110	9	8.5
P-40	S00375	2.57	2.50	9.79	9.86	8.66	8.99	136	270	62	68	240	260	56	19	116	130	36	31	128	120	8	8.5
P-42	S00376	2.07	1.90	15.4	15.8	10.33	10.49	247	360	53	65	270	290	15	12	215	190	255	270	256	230	7	6.5

Table C1. Identification and results of analyses of shales of the New Albany Group.

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO_2 (%)	Al_2O_3 (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)
S00001	01KY01C1	2182.25	1604731175	3417 GRCK	53.23	10.10	6.16	0.74	0.14	0.74	3.52	0.56	0.10
S00002	01KY02C1	2191.15	1604731175	3417 GRCK	59.33	9.65	4.86	1.21	1.63	0.66	3.06	0.50	0.06
S00003	01KY03C1	2220.30	1604731175	3417 GRCK	57.80	9.93	6.49	1.08	1.60	0.68	3.24	0.54	0.10
S00004	01KY04C1	2230.20	1604731175	3417 GRCK	62.77	14.99	3.52	1.49	0.56	0.86	4.54	0.71	<0.01
S00005	01KY05C1	2240.10	1604731175	3417 GRCK	48.02	10.00	8.47	1.69	7.30	0.74	2.75	0.45	4.25
S00006	01KY06C1	2250.00	1604731175	3417 SELM	58.97	16.36	3.96	1.98	1.25	0.98	4.84	0.83	0.07
S00007	01KY07C1	2260.30	1604731175	3417 SELM	50.72	14.38	6.46	1.05	0.29	0.77	4.19	0.70	0.07
S00008	01KY08C1	2270.30	1604731175	3417 SELM	57.87	14.38	3.03	2.10	2.03	0.92	4.86	0.73	0.13
S00033	01KY08L1	2273.50	1604731175	3417 SELM	54.97	14.53	4.54	1.82	1.69	0.84	5.00	0.71	0.12
S00009	01KY09C1	2280.00	1604731175	3417 SELM	51.86	11.52	3.24	3.59	4.81	0.80	3.66	0.71	0.01
S00034	01KY10L1	2287.80	1604731175	3417 SELM	54.33	11.88	2.61	3.62	5.67	0.75	4.05	0.71	0.03
S00010	01KY10C1	2290.75	1604731175	3417 SELM	52.98	11.54	2.38	2.83	3.69	0.75	4.38	0.68	0.05
S00035	01KY11L1	2292.95	1604731175	3417 SELM	51.78	10.85	3.08	3.47	5.58	0.78	3.96	0.63	0.04
S00011	01KY11C1	2299.75	1604731175	3417 SELM	45.01	9.77	3.85	4.75	7.50	0.87	3.53	0.52	0.19
S00012	01KY12C1	2310.50	1604731175	3447 BLCR	51.63	8.44	2.84	4.31	7.51	0.56	3.34	0.43	0.15
S00036	01KY12L1	2311.10	1604731175	3447 BLCR	49.82	8.07	2.36	4.25	10.25	0.53	3.03	0.37	0.19
S00037	01KY13L1	2312.65	1604731175	3447 BLCR	49.84	7.59	2.74	4.19	9.32	0.53	3.06	0.36	0.25
S00013	01KY13C1	2318.80	1604731175	3447 BLCR	46.03	7.07	2.78	4.08	11.67	0.45	3.02	0.35	0.19
S00393	02KY01C1	35.0	16029	3417 CLCR	49.53	10.83	8.17	0.51	0.48	0.42	3.28	0.63	0.16
S00394	02KY02C1	45.0	16029	3417 CLCR	48.32	9.81	8.04	0.88	0.70	0.47	3.37	0.58	0.09
S00395	02KY03C1	55.0	16029	3417 CPRN	60.83	13.19	5.20	0.45	1.11	0.68	4.10	0.80	0.11
S00396	02KY04C1	65.0	16029	3417 CPRN	57.27	14.77	4.61	1.23	1.35	0.66	4.74	0.82	0.07
S00397	02KY05C1	75.0	16029	3417 CPRN	56.63	14.64	4.79	1.06	0.98	0.64	4.80	0.73	0.09
S00398	02KY06C1	85.0	16029	3417 CPRN	53.25	12.28	9.19	0.93	2.35	0.48	3.85	0.58	0.05
S00399	02KY07C1	95.0	16029	3417 MGTR	57.30	15.15	4.76	1.14	1.32	0.52	4.87	0.68	0.05
S00400	02KY08C1	105.0	16029	3417 MGTR	52.34	12.02	3.56	2.19	3.44	0.38	4.40	0.65	0.09
S00401	02KY09C1	115.0	16029	3417 BLCR	45.08	8.99	2.62	5.19	9.58	0.15	2.83	0.42	0.14
S00014	01IL01L2	1576.0	1216700115	3397 HNBL	64.51	10.47	3.88	2.25	1.04	1.00	4.32	0.87	0.08
S00015	01IL03L1	1589.4	1216700115	3397 HNBL	71.81	8.54	2.35	1.84	2.03	1.25	3.43	0.93	0.33
S00016	01IL04L1	1602.0	1216700115	3397 HNBL	74.03	9.19	1.98	1.13	0.32	1.37	3.55	0.95	0.03
S00017	01IL05L1	1615.1	1216700115	3397 HNBL	70.44	9.77	2.59	1.48	0.39	1.22	4.11	0.99	<0.01
S00018	01IL07L1	1631.6	1216700115	3397 HNBL	51.65	6.81	1.86	2.59	16.22	0.88	2.80	0.56	0.31
S00019	01IL09L1	1647.4	1216700115	3417 SVRN	62.19	13.91	3.98	2.70	1.43	1.02	4.86	0.93	0.02
S00020	01IL09L2	1656.2	1216700115	3417 SVRN	65.39	12.10	4.25	1.62	0.30	1.11	4.95	1.00	0.05
S00021	01IL10L1	1657.6	1216700115	3417 SVRN	65.30	11.66	5.26	1.64	0.06	0.98	4.38	0.87	0.01
S00022	01IL11L1	1667.5	1216700115	3417 SVRN	57.90	14.90	4.50	1.90	0.01	0.71	6.10	0.84	0.06
S00023	01IL12L1	1678.6	1216700115	3417 SVRN	60.22	14.99	4.51	2.63	0.43	0.79	6.35	0.89	<0.01
S00024	01IL13L1	1688.0	1216700115	3417 SVRN	58.77	16.05	4.58	2.74	0.36	0.75	6.41	0.81	0.02
S00025	01IL14L1	1698.2	1216700115	3417 GRCK	56.51	14.11	4.68	2.22	0.52	0.75	5.31	0.77	<0.01
S00026	01IL15L1	1710.0	1216700115	3417 GRCK	53.21	14.78	5.25	2.17	0.33	0.59	5.90	0.66	0.05
S00027	01IL16L1	1723.4	1216700115	3417 GRCK	54.27	13.23	5.60	2.04	0.79	0.73	4.22	0.68	0.03
S00028	01IL17L1	1730.6	1216700115	3417 GRCK	58.92	13.46	4.81	1.54	0.69	0.82	4.02	0.66	0.04
S00029	01IL18L1	1740.2	1216700115	3417 GRCK	62.47	11.65	3.73	1.27	0.47	0.84	4.16	0.64	0.08
S00030	01IL19L1	1753.5	1216700115	3417 GRCK	56.15	13.43	5.67	1.67	0.68	0.75	4.64	0.62	0.10
S00031	01IL20L1	1763.3	1216700115	3417 GCSC	57.97	12.25	3.93	2.22	2.26	0.92	4.72	0.69	0.08
S00032	01IL21L1	1776.2	1216700115	3417 SDCK	56.42	14.75	4.35	2.15	0.77	0.71	5.52	0.67	0.03
S00038	02IL01L2	3009.5	1204922705	3397 CHUT	11.95	2.28	1.03	1.50	44.27	0.15	0.84	0.09	<0.01
S00051	02IL01C1	3011.4	1204922705	3397 HBSV	67.71	14.77	4.29	1.52	0.10	0.95	4.40	0.95	0.03
S00052	02IL02C1	3021.4	1204922705	3397 HBSV	67.32	13.93	3.80	1.43	0.27	0.98	4.54	0.92	0.04

Table C1. Continued.

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO_2 (%)	Al_2O_3 (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)
S00053	02IL03C1	3043.3	1204922705	3417 GRCK	61.60	11.49	5.40	1.27	1.38	0.63	3.84	0.69	0.01
S00054	02IL04C1	3053.0	1204922705	3417 GRCK	61.24	10.64	6.91	0.70	0.73	0.56	3.55	0.69	<0.01
S00055	02IL04C2	3059.5	1204922705	3417 GRCK	56.48	11.38	5.64	1.94	2.44	0.62	3.96	0.74	0.04
S00056	02IL05C1	3065.3	1204922705	3417 GRCK	56.69	13.79	5.87	0.90	0.86	0.73	4.48	0.79	0.06
S00039	02IL05L2	3071.5	1204922705	3417 GRCK	60.49	16.29	4.54	2.28	1.62	0.80	5.10	0.91	0.03
S00057	02IL06C1	3073.4	1204922705	3417 GRCK	57.70	14.62	5.24	1.19	0.44	0.73	4.57	0.85	0.08
S00040	02IL06L2	3081.1	1204922705	3417 SDCK	62.33	16.63	4.51	1.70	1.30	0.83	4.84	0.85	0.30
S00058	02IL07C1	3085.5	1204922705	3417 SDCK	58.67	14.96	5.60	1.24	0.90	0.77	4.48	0.80	0.06
S00059	02IL08C1	3096.5	1204922705	3417 SDCK	55.51	17.57	5.62	1.69	0.77	0.71	4.88	0.88	<0.01
S00041	02IL09L1	3105.8	1204922705	3447 LNGL	48.37	0.23	0.48	1.78	24.75	0.044	0.097	<0.01	0.67
S00042	03IL01L1	4480.	1219304694	3397 HBSV	35.67	10.20	3.50	1.73	20.99	0.48	3.17	0.44	0.11
S00043	03IL07L1	4540.	1219304694	3417 GRCK	59.13	10.49	6.02	1.33	1.89	0.76	3.29	0.59	0.06
S00044	03IL12L1	4590.	1219304694	3417 GRCK	59.22	13.99	5.11	0.97	0.93	0.77	4.30	0.67	0.08
S00045	03IL20L1	4673.	1219304694	3417 SELM	60.06	17.20	2.96	2.43	2.61	0.90	5.29	0.83	0.08
S00046	03IL20L3	4676.	1219304694	3417 SELM	52.56	13.92	3.97	3.76	5.65	0.83	4.34	0.69	0.07
S00047	03IL23L1	4705.	1219304694	3447 BLCR	56.13	12.39	4.85	2.93	3.90	0.74	3.98	0.60	0.10
S00048	03IL26L1	4735.	1219304694	3447 BLCR	56.29	12.32	2.38	3.01	4.47	0.62	4.25	0.56	0.14
S00096	04IL01C1	323.3	1207120411	3397 HBSV	52.63	15.32	3.90	3.71	3.75	0.31	6.77	0.80	<0.02
S00097	04IL02C1	333.05	1207120411	3397 HBSV	53.19	14.25	4.22	4.33	4.11	0.29	5.73	0.83	0.02
S00098	04IL03C1	343.4	1207120411	3397 HBSV	48.57	13.27	4.20	5.12	5.96	0.27	5.74	0.75	<0.02
S00099	04IL04C1	353.05	1207120411	3397 HBSV	50.09	14.87	4.34	4.51	4.46	0.29	6.41	0.77	0.05
S00100	04IL05C1	363.3	1207120411	3397 HBSV	47.11	13.09	4.70	4.81	5.79	0.26	6.10	0.65	0.02
S00101	04IL06C1	373.15	1207120411	3397 HBSV	49.51	14.38	4.55	4.56	4.76	0.28	6.25	0.70	0.02
S00102	04IL07C1	383.45	1207120411	3397 HBSV	49.59	14.96	4.32	4.28	4.20	0.30	7.21	0.73	0.02
S00103	04IL08C1	393.1	1207120411	3397 HBSV	50.53	15.91	4.53	4.36	4.48	0.29	6.47	0.73	0.02
S00104	04IL09C1	403.5	1207120411	3397 HBSV	51.24	16.12	4.44	4.19	3.50	0.31	7.04	0.77	0.02
S00105	04IL10C1	413.45	1207120411	3397 HBSV	52.31	15.89	4.54	3.73	2.80	0.32	6.86	0.77	<0.02
S00106	04IL11C1	424.4	1207120411	3397 HBSV	54.39	14.70	5.43	4.19	3.99	0.30	6.59	0.73	0.02
S00107	04IL12C1	433.3	1207120411	3397 HBSV	51.50	15.08	4.97	3.95	3.83	0.29	6.74	0.70	0.02
S00108	04IL13C1	443.2	1207120411	3397 HBSV	51.58	15.81	4.50	3.83	2.83	0.30	6.44	0.75	0.07
S00109	04IL14C1	453.05	1207120411	3397 HBSV	52.23	15.62	5.03	3.52	2.70	0.29	6.69	0.70	0.02
S00110	04IL15C1	463.2	1207120411	3417 GRCK	58.54	16.89	4.85	2.22	0.62	0.29	5.19	0.85	0.02
S00111	04IL16C1	473.0	1207120411	3417 GRCK	56.89	16.66	4.75	2.84	1.01	0.30	5.24	0.88	0.07
S00159	04IL17L1	480.2	1207120411	3417 GRCK	58.94	14.53	4.62	2.60	1.83	0.29	5.05	0.85	0.02
S00112	04IL17C1	482.35	1207120411	3417 GRCK	59.44	15.25	4.49	2.24	1.37	0.27	4.93	0.87	0.11
S00113	04IL18C1	493.2	1207120411	3417 SDCK	61.53	16.02	4.39	2.65	0.70	0.30	5.15	0.93	0.07
S00114	04IL19C1	503.25	1207120411	3417 SDCK	61.92	15.08	3.95	1.59	0.98	0.28	4.79	0.95	0.02
S00160	04IL19L1	505.7	1207120411	3417 SDCK	59.24	14.64	4.72	2.44	1.86	0.32	5.26	0.87	0.02
S00115	04IL20C1	513.35	1207120411	3417 SDCK	53.83	16.17	5.04	1.84	1.02	0.30	5.43	0.83	0.07
S00116	04IL21C1	523.2	1207120411	3417 SDCK	54.60	17.45	5.04	2.59	1.43	0.32	5.46	0.78	0.02
S00117	04IL22C1	533.0	1207120411	3417 SDCK	52.91	17.99	5.89	2.82	1.80	0.33	5.72	0.77	0.11
S00118	04IL23C1	542.2	1207120411	3417 SDCK	53.96	18.61	5.51	2.79	1.47	0.32	5.64	0.78	0.04
S00119	04IL24C1	553.4	1207120411	3417 SDCK	51.41	17.27	4.89	3.33	3.13	0.32	5.42	0.75	0.07
S00120	04IL25C1	563.2	1207120411	3417 SDCK	51.65	16.30	4.49	4.16	4.14	0.30	5.35	0.75	<0.02
S00121	04IL26C1	573.0	1207120411	3417 SDCK	54.75	17.48	5.83	2.82	1.23	0.33	5.81	0.80	0.11
S00161	04IL27L1	582.6	1207120411	3417 SDCK	42.38	11.86	3.85	6.78	9.98	0.28	4.70	0.73	0.21
S00122	04IL27C1	583.4	1207120411	3417 SDCK	27.83	8.33	3.65	9.93	17.01	0.18	2.78	0.35	0.25
S00123	04IL28C1	593.2	1207120411	3417 SDCK	33.91	9.71	3.19	8.82	14.00	0.21	3.43	0.45	0.02
S00162	04IL29L1	603.2	1207120411	3417 SDCK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 61. Continued.

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO_2 (%)	Al_2O_3 (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)
S00124	04IL29C1	604.5	1207120411	3447 CDVL	30.70	2.49	3.00	10.23	21.02	0.081	1.03	0.12	0.02
S00125	04IL30C1	613.3	1207120411	3447 CDVL	8.24	2.87	1.16	7.24	37.81	0.086	1.00	0.10	0.02
S00172	05IL01L1	655.9	1204501209	3417 SDCK	52.35	15.91	6.00	2.06	1.27	0.33	5.34	0.73	0.02
S00173	05IL01L2	660.2	1204501209	3417 SDCK	56.01	14.81	4.89	1.82	0.85	0.33	5.54	0.82	0.02
S00174	05IL01L3	662.2	1204501209	3417 SDCK	53.62	14.21	5.67	2.26	1.40	0.31	5.27	0.78	0.02
S00073	06IL04C1	933.4	1217921198	3397 HBSV	56.29	14.06	4.20	3.22	3.83	0.28	5.35	0.83	0.02
S00074	06IL05C1	943.5	1217921198	3397 HBSV	57.16	16.38	4.97	2.40	1.61	0.32	6.01	0.92	<0.02
S00075	06IL06C1	954.0	1217921198	3397 HBSV	54.59	14.04	4.55	4.00	4.06	0.28	5.05	0.87	<0.02
S00076	06IL07C1	962.25	1217921198	3397 HBSV	57.49	11.39	3.91	3.71	4.51	0.25	4.59	0.80	<0.02
S00077	06IL08C1	973.35	1217921198	3397 HBSV	52.63	15.95	6.14	2.97	2.55	0.32	5.88	0.85	0.05
S00078	06IL09C1	984.2	1217921198	3397 HBSV	55.82	14.42	4.95	3.37	2.73	0.33	5.76	0.95	0.02
S00079	06IL10C1	993.1	1217921198	3397 HBSV	55.05	15.42	5.36	2.95	2.35	0.33	6.22	0.87	0.09
S00080	06IL11C1	1003.2	1217921198	3397 HBSV	56.29	16.44	5.31	2.77	1.53	0.31	5.93	0.88	0.02
S00163	06IL11L1	1005.3	1217921198	3397 HBSV	50.45	13.85	5.13	5.49	6.06	0.27	5.00	0.82	0.02
S00081	06IL12C1	1014.1	1217921198	3397 HBSV	55.24	15.51	5.08	2.17	1.40	0.31	5.83	0.92	0.02
S00082	06IL13C1	1024.1	1217921198	3397 HBSV	56.80	16.61	5.42	3.40	3.06	0.31	6.06	0.87	0.02
S00164	06IL13L1	1025.5	1217921198	3397 HBSV	55.80	16.44	4.99	3.18	1.80	0.35	6.73	0.85	<0.02
S00165	06IL13L2	1029.1	1217921198	3397 HBSV	57.10	17.00	5.35	2.19	0.67	0.36	6.99	0.87	<0.02
S00166	06IL14L1	1032.75	1217921198	3397 HBSV	48.18	14.83	4.99	4.56	5.23	0.33	6.52	0.72	0.02
S00083	06IL14C1	1034.25	1217921198	3397 HBSV	53.19	16.97	4.98	2.82	2.28	0.32	6.59	0.78	0.05
S00084	06IL15C1	1044.1	1217921198	3397 HBSV	55.12	17.20	5.68	2.75	1.86	0.31	6.13	0.85	0.05
S00085	06IL16C1	1053.15	1217921198	3397 HBSV	54.90	15.57	5.16	2.67	2.48	0.32	6.50	0.83	0.05
S00086	06IL17C1	1063.25	1217921198	3397 HBSV	53.53	14.74	5.18	3.12	3.30	0.27	6.37	0.73	0.05
S00087	06IL18C1	1073.3	1217921198	3397 HBSV	54.66	15.55	4.73	1.36	0.88	0.29	7.07	0.75	0.05
S00088	06IL19C1	1083.2	1217921198	3417 GRCK	53.77	15.49	5.44	1.58	0.74	0.28	6.63	0.70	0.05
S00167	06IL19L1	1085.25	1217921198	3417 GRCK	55.11	15.46	6.16	1.66	0.31	0.29	6.25	0.72	0.02
S00089	06IL20C1	1093.35	1217921198	3417 GRCK	52.55	13.64	6.45	1.56	0.38	0.23	4.97	0.80	0.07
S00168	06IL21L1	1101.8	1217921198	3417 GRCK	51.99	11.69	7.96	0.98	2.64	0.22	4.51	0.70	0.18
S00090	06IL21C1	1103.1	1217921198	3417 GRCK	55.54	16.25	5.47	0.83	0.10	0.27	5.50	0.83	0.05
S00169	06IL22L1	1111.4	1217921198	3417 SDCK	58.09	16.46	4.77	1.79	0.52	0.28	5.46	0.87	0.02
S00091	06IL22C1	1113.4	1217921198	3417 SDCK	58.24	17.40	4.93	1.23	0.35	0.30	5.76	0.88	0.11
S00092	06IL23C1	1123.5	1217921198	3417 SDCK	53.72	18.02	5.38	2.17	1.08	0.32	5.98	0.77	<0.02
S00093	06IL24C1	1133.5	1217921198	3417 SDCK	58.09	11.90	3.77	3.22	4.63	0.24	4.67	0.75	0.07
S00170	06IL25L1	1141.1	1217921198	3417 SDCK	59.37	14.15	3.83	2.09	2.38	0.26	5.29	0.80	0.05
S00094	06IL25C1	1143.5	1217921198	3417 SDCK	59.95	16.06	4.43	2.07	1.46	0.28	5.78	0.78	0.02
S00171	06IL25L2	1145.7	1217921198	3447 CDVL	31.49	5.61	4.80	7.34	17.77	0.15	2.45	0.27	0.27
S00126	07IL01L1	2720.	1205100825	3397 CHUT	6.59	1.22	1.02	1.32	45.35	0.11	0.63	0.05	0.04
S00127	07IL01L2	2731.	1205100825	3397 HNBL	56.53	16.06	4.39	1.76	0.15	0.68	6.13	0.83	0.02
S00128	07IL01L3	2737.	1205100825	3397 HNBL	46.96	13.23	3.95	3.45	10.90	0.73	4.25	0.67	0.11
S00129	07IL02L1	2771.8	1205100825	3397 HNBL	68.01	14.03	3.51	1.03	0.21	1.04	4.94	0.93	0.05
S00130	07IL02L2	2773.0	1205100825	3417 LUSN	27.30	5.33	2.64	2.62	28.20	0.39	2.03	0.33	0.07
S00131	07IL03L1	2780.4	1205100825	3417 SVRN	69.38	14.32	3.02	1.41	0.21	1.03	4.78	0.93	0.02
S00132	07IL04L1	2810.9	1205100825	3417 GRCK	55.88	14.87	5.62	1.31	0.84	0.80	5.04	0.85	0.09
S00133	07IL04L2	2813.1	1205100825	3417 SDCK	54.71	14.87	5.85	1.62	0.85	0.77	5.04	0.83	0.02
S00134	07IL05L1	2821.5	1205100825	3417 SLMR	70.31	0.64	1.00	3.13	10.50	0.087	0.27	0.02	<0.02
S00135	09IL01L3	1774.	1216301757	3417 GCSC	54.79	14.47	4.48	1.74	0.49	0.66	4.46	0.65	0.11
S00323	10IL01L1	2892.2	1205125257	3417 SDCK	54.09	16.18	5.49	2.13	0.98	0.79	4.86	0.69	0.05
S00324	10IL01L2	2896.2	1205125257	3417 SDCK	55.37	15.79	4.14	2.82	2.71	0.72	4.47	0.75	0.08
S00325	10IL01L3	2898.2	1205125257	3417 SDMR	75.44	5.65	3.02	1.78	3.78	0.41	1.51	0.34	0.36

Table C1. Continued.

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO$_2$ (%)	Al$_2$O$_3$ (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na$_2$O (%)	K$_2$O (%)	TiO$_2$ (%)	P$_2$O$_5$ (%)
S00326	10IL01L4	2900.5	1205125257	3447 LNGL	23.93	5.37	1.76	4.16	29.88	0.29	1.58	0.19	0.13
S00327	10IL01L5	2901.4	1205125257	3447 LNGL	53.12	2.08	1.27	4.02	20.09	0.12	0.68	0.09	0.37
S00328	10IL01L6	2902.9	1205125257	3447 LNGL	30.08	6.48	2.53	8.65	20.59	0.27	2.29	0.33	0.10
S00329	10IL01L7	2903.8	1205125257	3447 LNGL	70.40	0.68	0.43	2.98	13.86	0.034	0.16	0.02	0.12
S00330	11IL02C1	48.0	1206920746	3417 GRCK	60.34	18.56	4.24	0.26	0.16	1.83	4.60	0.79	0.05
S00331	11IL03C1	70.8	1206920746	3417 GRCK	56.95	15.57	5.61	0.63	1.42	3.33	6.41	0.69	0.09
S00377	11IL04L1	80.7	1206920746	3417 GRCK	63.09	10.54	3.72	1.44	3.33	3.05	3.98	0.75	0.32
S00378	11IL04L*	80.7	1206920746	340 DVNN	27.45	8.20	8.09	6.76	14.40	0.86	2.94	2.70	1.28
S00332	11IL04C1	83.0	1206920746	3417 GRCK	54.45	14.65	4.83	1.40	1.89	5.24	4.55	0.73	0.05
S00333	11IL05C1	93.5	1206920746	3417 SELM	58.88	17.11	4.77	1.40	2.40	1.69	6.72	0.81	0.02
S00334	11IL06C1	101.45	1206920746	3417 SELM	54.51	16.36	4.93	2.08	3.05	4.22	6.03	0.79	0.01
S00335	11IL07C2	117.8	1206920746	3417 SELM	58.28	18.31	5.21	1.47	0.74	0.97	6.90	0.91	0.01
S00336	11IL08C1	120.2	1206920746	3417 SELM	58.75	15.62	6.21	1.94	1.55	1.26	5.56	0.86	0.09
S00337	11IL09C1	129.7	1206920746	3417 SELM	42.90	12.31	5.54	4.06	9.17	3.53	5.41	0.62	0.05
S00338	11IL10C1	141.35	1206920746	3417 SELM	54.76	15.27	4.60	1.94	3.25	5.82	4.90	0.82	0.03
S00379	11IL10L1	146.4	1206920746	3417 SELM	39.58	10.64	6.06	4.77	10.51	2.84	4.97	0.57	0.02
S00339	11IL11C1	152.0	1206920746	3417 SELM	54.34	14.51	4.38	2.31	3.80	3.12	6.57	0.77	0.14
S00380	11IL11L1	157.0	1206920746	3417 SELM	52.87	12.94	3.80	2.79	5.92	2.24	7.64	0.68	0.11
S00340	11IL12C1	164.0	1206920746	3417 SELM	52.92	14.87	5.24	1.85	2.82	6.43	4.52	0.78	0.06
S00381	11IL12L1	167.2	1206920746	3417 SELM	48.01	13.04	4.01	3.42	7.58	4.35	4.80	0.70	0.05
S00341	11IL13C1	171.6	1206920746	3417 SELM	53.51	14.96	6.04	0.82	1.33	3.81	6.45	0.76	0.10
S00342	11IL14C1	184.85	1206920746	3417 SELM	56.95	15.16	5.16	1.88	1.87	3.29	6.33	0.66	0.09
S00343	11IL15C1	195.6	1206920746	3417 SELM	60.61	12.65	4.39	1.16	0.94	2.97	4.59	0.60	0.09
S00344	11IL16C1	205.1	1206920746	3417 SELM	64.07	10.15	4.06	1.66	2.51	3.06	4.64	0.51	0.04
S00345	11IL17C1	216.0	1206920746	3417 SELM	56.00	15.06	4.45	2.07	2.60	2.16	6.85	0.74	0.04
S00346	11IL17C2	222.1	1206920746	3417 SELM	57.54	11.62	8.08	1.03	1.65	3.64	4.33	0.57	0.11
S00347	11IL18C1	230.0	1206920746	3417 SELM	57.07	15.32	4.39	1.85	1.63	2.04	8.11	0.72	0.02
S00348	11IL19C1	241.4	1206920746	3417 SELM	63.71	12.15	3.25	1.61	3.26	4.10	4.47	0.48	0.06
S00349	11IL20C1	251.4	1206920746	3417 SELM	58.27	11.53	4.12	2.06	5.27	4.19	4.08	0.44	0.08
S00350	11IL21C1	260.1	1206920746	3417 SELM	50.40	11.77	3.57	3.86	6.85	4.25	4.66	0.64	0.02
S00402	12IL01C1	4834.1	1219129348	3417 GRCK	54.56	14.57	6.07	0.98	0.27	0.60	5.25	0.72	0.16
S00403	12IL01C2	4838.0	1219129348	3417 GRCK	60.07	14.91	4.60	0.85	0.38	0.70	5.29	0.75	0.14
S00404	12IL01C3	4843.0	1219129348	3417 GRCK	61.96	13.26	3.49	0.96	1.16	0.55	4.29	0.63	0.11
S00405	12IL01C4	4846.25	1219129348	3417 GRCK	62.26	14.15	4.62	0.98	0.46	0.67	4.77	0.72	0.11
S00407	13IL04C1	5046.3	1219129436	3397 HBSV	49.94	13.79	4.04	2.69	10.07	0.63	4.56	0.63	0.06
S00408	13IL05C1	5054.6	1219129436	3417 GRCK	60.29	16.51	4.18	1.13	0.21	0.75	5.23	0.83	0.03
S00409	13IL06C2	5069.6	1219129436	3417 GRCK	66.56	14.42	3.60	0.90	0.15	0.75	4.50	0.77	0.06
S00410	13IL07C2	5078.1	1219129436	3417 GRCK	62.17	10.32	3.85	1.29	2.83	0.60	3.27	0.55	0.08
S00411	13IL08C1	5082.2	1219129436	3417 GRCK	69.41	11.49	3.05	0.58	0.27	0.73	3.69	0.68	0.05
S00412	13IL09C1	5090.3	1219129436	3417 GRCK	52.43	13.21	6.55	1.84	2.29	0.66	4.32	0.63	0.07
S00413	13IL10C1	5100.3	1219129436	3417 GRCK	54.36	12.83	6.09	1.69	2.01	0.71	4.07	0.58	0.07
S00414	13IL11C2	5115.4	1219129436	3417 GRCK	60.40	13.02	7.10	0.81	0.36	0.85	3.92	0.73	0.08
S00415	13IL12C3	5128.6	1219129436	3417 GRCK	58.56	14.49	7.05	0.99	0.38	0.78	4.37	0.72	0.09
S00416	13IL13C2	5135.3	1219129436	3417 GRCK	64.06	11.98	5.91	0.80	0.62	0.68	3.55	0.60	0.02
S00417	13IL14C3	5148.4	1219129436	3417 GRCK	54.45	15.87	5.63	1.38	0.73	0.80	4.71	0.75	0.08
S00418	13IL15C2	5154.3	1219129436	3417 GRCK	54.90	16.19	5.40	1.21	0.62	0.85	4.82	0.77	0.07
S00419	13IL16C2	5164.1	1219129436	3417 GRCK	54.30	17.44	5.65	1.49	0.57	0.78	5.07	0.70	0.06
S00420	13IL17C4	5178.2	1219129436	3417 GRCK	53.44	14.36	4.73	3.05	4.30	0.84	4.39	0.63	0.03
S00421	13IL18C2	5184.1	1219129436	3417 GRCK	58.19	16.08	5.34	1.66	1.55	0.92	4.46	0.82	0.06

* Sample 11IL04L* is a dike in 11IL04L1.

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO_2 (%)	Al_2O_3 (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)
S00422	13IL19C1	5190.2	1219129436	3417 SELM	56.95	14.64	4.79	2.97	3.64	0.88	4.31	0.73	0.07
S00423	13IL20C1	5202.1	1219129436	3417 SELM	60.21	15.70	4.49	2.25	2.25	0.88	4.78	0.80	0.03
S00424	13IL21C2	5214.0	1219129436	3417 SELM	57.81	14.55	4.31	2.12	2.50	0.97	4.49	0.75	0.08
S00425	13IL22C2	5224.5	1219129436	3417 SELM	59.22	16.12	4.22	2.09	1.79	0.88	5.03	0.78	0.05
S00426	13IL23C4	5239.6	1219129436	3417 SELM	58.45	15.96	5.12	1.56	1.20	0.85	4.76	0.55	0.07
S00427	13IL24C2	5245.5	1219129436	3417 SELM	50.13	11.58	3.33	5.24	8.12	0.78	3.59	0.40	0.02
S00428	13IL25C3	5258.4	1219129436	3447 BLCR	33.61	7.42	1.80	3.40	24.22	0.55	2.46	0.27	0.08
S00429	13IL26C3	5267.2	1219129436	3447 BLCR	43.97	8.62	2.55	4.03	15.95	0.51	2.59	0.38	0.08
S00430	13IL27C1	5270.5	1219129436	3447 BLCR	43.28	7.90	1.97	3.58	17.95	0.46	2.81	0.33	0.07
S00352	01IN01C1	2504.2	1315320084	3417 GRCK	55.15	13.70	4.16	1.26	0.48	0.56	4.49	0.71	0.22
S00353	01IN01C2	2505.9	1315320084	3417 GRCK	63.76	11.66	3.84	0.88	0.52	0.54	3.74	0.62	0.16
S00354	01IN02C1	2515.7	1315320084	3417 GRCK	62.18	11.14	4.24	1.34	1.48	0.54	3.94	0.61	0.13
S00355	01IN03C1	2521.5	1315320084	3417 GRCK	61.63	12.14	4.97	1.74	2.02	0.50	4.04	0.59	0.05
S00356	01IN03C2	2524.2	1315320084	3417 GRCK	58.44	12.91	5.79	1.72	1.42	0.55	4.36	0.67	0.08
S00357	01IN03C3	2528.2	1315320084	3417 GRCK	53.88	12.16	6.67	1.53	1.84	0.55	3.92	0.66	0.08
S00358	01IN04C1	2531.4	1315320084	3417 GRCK	54.41	11.34	7.54	0.97	0.77	0.58	3.63	0.62	0.19
S00359	01IN04C2	2536.9	1315320084	3417 GRCK	54.86	10.43	6.59	1.50	2.09	0.67	3.51	0.66	0.15
S00360	01IN05C1	2545.1	1315320084	3417 GRCK	56.77	13.78	5.33	1.04	0.70	0.73	4.22	0.79	0.08
S00361	01IN05C2	2547.5	1315320084	3417 GRCK	56.12	15.25	5.13	1.48	1.05	0.71	4.56	0.80	0.02
S00362	01IN05C3	2549.9	1315320084	3417 GRCK	56.82	15.25	5.19	1.44	1.17	0.69	4.71	0.84	0.08
S00363	01IN07C1	2561.8	1315320084	3417 GRCK	55.97	16.79	5.48	1.51	1.05	0.71	5.21	0.77	0.06
S00364	01IN07C2	2565.6	1315320084	3417 GRCK	55.79	17.35	5.43	1.98	1.17	0.70	5.24	0.72	0.07
S00365	01IN08C1	2571.5	1315320084	3417 GRCK	55.02	16.11	5.64	1.44	0.88	0.67	5.06	0.70	0.06
S00366	01IN08C2	2579.0	1315320084	3417 GRCK	54.00	14.67	5.94	1.65	1.05	0.63	4.57	0.64	0.06
S00367	01IN09C1	2585.6	1315320084	3417 GRCK	54.18	14.57	5.57	1.45	1.09	0.61	4.70	0.67	0.09
S00368	01IN09C2	2589.3	1315320084	3417 GRCK	58.12	14.77	4.09	2.38	2.92	0.84	4.82	0.90	0.07
S00369	01IN10C1	2590.7	1315320084	3417 SELM	17.88	4.19	6.41	10.75	23.21	0.26	1.44	0.22	0.02
S00370	01IN10C2	2591.5	1315320084	3417 SELM	57.39	14.58	4.66	2.11	2.72	0.68	4.74	0.76	0.06
S00371	01IN10C3	2598.8	1315320084	3417 SELM	58.93	14.11	5.59	1.21	0.73	0.58	4.52	0.65	0.06
S00372	01IN11C1	2600.5	1315320084	3417 SELM	53.94	12.65	6.08	1.32	1.24	0.57	4.43	0.63	0.09
S00373	01IN11C2	2606.3	1315320084	3417 SELM	52.37	14.11	4.20	2.81	4.16	0.57	4.55	0.66	0.09
S00374	01IN11C3	2619.2	1315320084	3447 BLCR	49.07	11.07	4.09	3.95	7.28	0.43	3.89	0.56	0.05
S00375	01IN13C1	2622.8	1315320084	3447 BLCR	46.51	10.37	4.10	3.54	8.94	0.42	3.90	0.50	0.04
S00376	01IN13C2	2626.5	1315320084	3447 BLCR	39.23	8.22	3.11	3.60	17.34	0.32	2.96	0.35	0.11
S00049	71477A	0.	34141	+	63.58	15.22	1.73	0.61	<0.01	0.34	4.20	0.95	0.04
S00050	71477B	0.	34141	+	68.50	16.15	2.92	0.58	0.03	0.26	4.42	0.99	0.04
S00136	NAS-0021	0.	12069		65.64	9.99	4.44	1.29	2.43	0.54	3.82	0.50	0.09
S00137	NAS-0025	0.	12181		59.86	11.58	5.04	1.81	1.30	0.46	4.10	0.60	0.02
S00138	NAS-0028	4420.	1202505036	3417 GRCK	59.61	14.23	5.16	1.49	2.06	0.67	4.02	0.73	0.11
S00139	NAS-0031	3920.	1204922498	3417 GRCK	55.13	12.28	6.73	1.64	3.95	0.70	3.52	0.68	0.09
S00140	NAS-0032	3990.	1204922498	3417 GRCK	57.45	17.83	5.22	2.07	0.78	0.72	5.06	0.77	0.07
S00141	NAS-0033	3645.	1208101167	3417 GRCK	60.98	13.45	5.13	1.34	2.32	0.56	3.74	0.67	0.07
S00142	NAS-0036	1590.	1211901187	3397 HNBL	49.29	9.92	3.85	3.03	11.46	0.49	3.24	0.62	0.05
S00143	NAS-0037	1640.	1211901187	3417 GRCK	52.42	13.72	4.41	3.05	4.88	0.44	4.61	0.72	0.07
S00144	NAS-0041	435.	1212500062	3397 HNBL	59.76	13.66	4.14	2.62	1.97	0.42	5.09	0.98	0.05
S00145	NAS-0043	550.	1212500062	3417 GRCK	56.50	16.42	4.93	2.72	0.62	0.43	5.50	0.77	0.02
S00146	NAS-0045	2690.	1218902866	3417 GRCK	57.15	12.30	4.63	2.09	3.66	0.82	3.64	0.75	0.09
S00147	NAS-0046	2900.	1218923041	3417 GRCK	59.58	11.81	4.31	1.86	3.26	0.54	3.70	0.57	0.02
S00148	NAS-0050	2665.	1218922957	3417 GRCK	51.18	13.38	5.83	1.43	0.92	0.64	4.26	0.75	0.04

+ Cleveland Member of Ohio Shale.

Table C1. Continued.

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO_2 (%)	Al_2O_3 (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)
S00149	NAS-0054	4720.	1219100089	3417 GRCK	60.59	11.39	5.27	1.34	1.79	0.67	3.84	0.67	0.04
S00150	NAS-0057	4640.	1219106524	3417 GRCK	62.75	12.77	3.80	0.83	0.91	0.58	4.54	0.68	0.04
S00151	NAS-0059	4745.	1219106524	3417 GRCK	55.56	14.00	6.66	1.26	0.87	0.61	4.58	0.65	0.09
S00152	NAS-0061	4775.	1219100503	3417 GRCK	64.16	10.22	4.57	1.66	1.04	0.57	4.49	0.65	0.11
S00153	NAS-0062	4885.	1219100503	3417 SDCK	57.10	13.47	5.22	2.34	2.91	0.68	4.25	0.77	0.05
S00154	NAS-0065	4940.	1219104404	3417 GRCK	60.98	12.68	3.69	1.19	2.01	0.66	4.48	0.68	0.16
S00155	NAS-0067	5040.	1219104404	3417 GRCK	62.32	13.68	4.46	1.23	0.80	0.71	4.32	0.60	0.02
S00156	NAS-0068	5135.	1219104404	3447 BLCR	38.17	8.20	2.07	3.38	18.99	0.57	3.11	0.37	<0.02
S00157	NAS-0070	4985.	1219104240	3417 GRCK	61.85	13.62	3.78	1.39	1.76	0.65	4.42	0.72	0.27
S00158	NAS-0072	5150.	1219104240	3417 SDCK	58.28	14.94	4.71	2.16	1.94	0.80	4.62	0.73	0.02
S00175	NAS-0084	2180.	1202102375	3397 HNBL	64.04	13.89	4.16	1.44	0.27	0.75	5.31	0.97	<0.01
S00176	NAS-0087	2280.	1202102375	3417 GRCK	55.58	13.05	5.43	0.98	0.91	0.68	4.87	0.75	0.05
S00177	NAS-0090	4355.	1205902832	3417 GRCK	59.99	10.71	4.73	1.03	2.77	0.58	3.63	0.57	0.23
S00178	NAS-0091	4455.	1205902832	3417 SDCK	62.37	12.71	4.19	1.34	1.44	0.69	3.69	0.62	0.02
S00179	NAS-0092	4555.	1205902832	3417 SDCK	57.17	13.09	4.16	2.45	3.39	0.75	3.76	0.60	0.11
S00180	NAS-0093	3980.	1205903316	3417 GRCK	69.53	10.69	3.07	0.91	0.84	0.59	3.48	0.58	0.14
S00181	NAS-0094	4090.	1205903316	3417 GRCK	59.91	15.96	4.89	1.64	0.91	0.81	4.25	0.68	0.09
S00182	NAS-0095	4190.	1205903316	3417 SDCK	62.02	14.74	4.63	1.62	1.30	0.77	4.05	0.63	0.09
S00183	NAS-0096	4300.	1205903316	3447 BLCR	50.06	9.84	1.98	3.53	11.81	0.47	3.26	0.42	0.09
S00184	NAS-0102	500.	1206100189	3417 GRCK	57.19	15.10	4.70	2.06	0.71	0.43	4.86	0.78	0.09
S00185	NAS-0103	2780.	1210107425	3417 GRCK	57.77	13.45	5.38	1.46	1.58	0.50	4.41	0.65	0.09
S00186	NAS-0104	2890.	1210107425	3417 SDCK	55.20	15.04	3.82	3.00	3.43	0.56	4.58	0.67	0.07
S00187	NAS-0106	1033.	1210700113	3397 HNBL	62.54	15.36	5.04	1.97	0.50	0.48	5.68	1.07	0.02
S00188	NAS-0107	1154.	1210700113	3417 GRCK	55.22	14.26	6.52	1.77	0.87	0.25	4.88	0.70	0.05
S00189	NAS-0110	1880.	1211500823	3417 GRCK	54.73	15.74	5.22	1.69	0.78	0.60	4.55	0.83	0.05
S00190	NAS-0112	1930.	1211500823	3417 SDCK	53.32	16.36	4.77	2.29	2.53	0.54	3.83	0.83	0.02
S00191	NAS-0114	3030.	1215100244	3417 GRCK	61.38	11.35	4.50	1.33	3.54	0.62	3.39	0.57	1.74
S00192	NAS-0115	3140.	1215100244	3417 GRCK	61.60	16.36	4.63	1.96	0.85	0.84	4.30	0.72	0.09
S00193	NAS-0116	3250.	1215100244	3417 SDCK	59.05	16.53	4.40	2.44	2.18	0.84	4.22	0.80	0.02
S00194	NAS-0117	3330.	1215100244	3447 BLCR	49.32	8.90	2.17	2.87	12.77	0.54	3.02	0.38	0.16
S00195	NAS-0119	3940.	1216523981	3417 GRCK	62.24	11.43	4.17	1.09	2.55	0.73	3.90	0.62	0.41
S00196	NAS-0120	4030.	1216523981	3417 SDCK	63.22	13.04	4.00	1.11	2.06	0.73	4.01	0.60	0.09
S00197	NAS-0121	4140.	1216523981	3417 SDCK	61.66	13.28	4.10	2.07	2.29	0.77	3.99	0.65	0.09
S00198	NAS-0123	2440.	1216503505	3347 SPGV	56.95	14.04	4.36	1.56	3.75	0.73	4.84	0.70	0.69
S00199	NAS-0124	2550.	1216503505	3417 GRCK	56.16	15.02	7.32	1.34	0.98	0.81	4.42	0.68	0.05
S00200	NAS-0125	2650.	1216503505	3417 SDCK	55.22	14.28	4.58	2.80	3.50	0.82	4.17	0.77	0.05
S00201	NAS-0126	2750.	1216503505	3447 BLCR	54.79	9.27	2.70	3.03	8.94	0.64	3.36	0.45	0.11
S00202	NAS-0129	3705.	1218526176	3417 GRCK	69.03	11.37	3.31	0.75	1.12	0.52	3.63	0.60	0.07
S00203	NAS-0130	3795.	1218526176	3417 GRCK	61.06	14.38	5.88	1.21	1.04	0.71	4.19	0.70	0.07
S00204	NAS-0131	3895.	1218526176	3447 BLCR	40.31	9.18	3.28	3.50	15.61	0.47	3.06	0.38	0.07
S00205	NAS-0134	770.	1220300235	3397 HNBL	49.68	11.26	4.58	4.69	7.11	0.24	4.45	0.62	0.07
S00206	NAS-0135	875.	1220300235	3417 GRCK	52.87	14.94	5.00	2.49	2.76	0.26	4.96	0.77	0.07
S00207	NAS-0138	620.	1201901424	3417 GRCK	55.01	15.49	4.89	2.35	0.87	0.37	5.25	0.83	0.05
S00208	NAS-0141	2780.	1202122776	3417 GRCK	55.28	16.42	4.97	1.59	0.15	0.53	5.83	0.85	0.01
S00209	NAS-0144	4420.	1202501447	3417 GRCK	62.79	11.64	4.40	1.23	1.40	0.49	4.05	0.60	<0.01
S00210	NAS-0145	4520.	1202501447	3417 SDCK	55.99	13.68	4.58	2.69	3.81	0.68	4.19	0.77	0.07
S00211	NAS-0148	2300.	1202323824	3417 GRCK	55.63	12.28	6.02	1.29	1.32	0.53	4.09	0.70	0.05
S00212	NAS-0151	3005.	1202922459	3417 GRCK	54.58	16.40	5.82	1.72	0.32	0.48	5.16	0.83	<0.01
S00213	NAS-0153	2980.	1202922450	3397 HNBL	54.43	16.12	5.02	1.44	0.24	0.47	5.74	0.85	0.05

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO_2 (%)	Al_2O_3 (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)
S00214	NAS-0156	2860.	1203300524	3417 GRCK	58.72	11.54	5.07	1.13	1.44	0.51	3.91	0.62	0.07
S00215	NAS-0159	3990.	1203300710	3417 GRCK	59.76	14.23	3.85	0.98	1.11	0.62	4.58	0.75	0.21
S00216	NAS-0161	4120.	1203300710	3417 SDCK	56.59	15.72	4.98	2.25	1.15	0.67	4.72	0.78	0.01
S00217	NAS-0162	2870.	1203302498	3447 BLCR	55.33	14.89	4.10	1.96	2.22	0.52	4.60	0.73	0.07
S00218	NAS-0165	2650.	1203300294	3417 GRCK	57.40	14.47	5.13	1.61	2.10	0.43	4.06	0.78	0.18
S00219	NAS-0166	2670.	1203330012	3417 GRCK	59.22	12.90	4.10	1.59	1.04	0.61	4.45	0.75	0.09
S00220	NAS-0167	2790.	1203330012	3447 BLCR	55.07	15.93	4.40	2.52	2.74	0.59	4.70	0.77	0.02
S00221	NAS-0170	3740.	1203521385	3417 GRCK	58.17	13.21	5.26	2.24	1.15	0.62	4.55	0.73	0.07
S00222	NAS-0174	1050.	1203900391	3417 GRCK	56.25	14.93	5.33	2.09	0.50	0.28	5.13	0.85	0.07
S00223	NAS-0176	1785.	1204500517	3417 GRCK	52.08	11.85	6.37	2.19	2.01	0.47	4.04	0.73	0.14
S00224	NAS-0177	640.	1204500966	3417 GRCK	57.55	15.59	5.00	2.04	0.77	0.21	5.03	0.85	0.02
S00225	NAS-0181	4130.	1204922476	3417 GRCK	57.10	15.40	5.90	2.20	1.37	0.72	4.66	0.82	<0.01
S00226	NAS-0183	5090.	1206501276	3417 GRCK	63.39	12.79	4.79	1.44	1.32	0.63	4.33	0.67	0.01
S00227	NAS-0185	5190.	1206501276	3417 SDCK	56.63	14.08	4.75	2.22	2.34	0.72	4.52	0.75	0.05
S00228	NAS-0189	4950.	1206500760	3417 GRCK	59.93	12.65	4.94	1.41	1.96	0.60	4.10	0.63	0.07
S00229	NAS-0192	4880.	1206503450	3417 GRCK	55.24	14.57	4.62	1.81	2.15	0.70	4.68	0.73	0.05
S00230	NAS-0193	4990.	1206503450	3447 BLCR	47.63	7.63	1.79	3.45	14.08	0.62	2.78	0.33	0.09
S00231	NAS-0195	400.	1207500996	3397 HNBL	53.19	16.25	5.27	2.55	1.25	0.34	6.50	0.77	0.01
S00232	NAS-0196	490.	1207500996	3417 GRCK	54.58	15.81	5.58	2.27	0.97	0.33	6.00	0.77	0.01
S00233	NAS-0198	310.	1207501015	3417 GRCK	54.41	15.36	5.40	2.20	0.87	0.22	5.32	0.80	0.05
S00234	NAS-0202	4150.	1207922576	3417 GRCK	56.85	17.36	5.89	2.06	1.02	0.68	4.92	0.77	0.02
S00235	NAS-0206	4630.	1208122946	3417 GRCK	62.54	12.66	4.77	1.71	1.26	0.73	3.61	0.63	0.14
S00236	NAS-0207	3080.	1210127798	3417 GRCK	63.91	12.37	4.23	1.44	1.55	0.53	4.05	0.63	0.09
S00237	NAS-0208	3190.	1210127798	3417 SDCK	55.73	14.87	4.90	1.96	1.50	0.65	4.57	0.73	0.11
S00238	NAS-0212	3720.	1212125806	3417 GRCK	54.84	15.27	5.21	1.94	1.20	0.70	4.56	0.73	0.09
S00239	NAS-0213	3525.	1210102628	3417 GRCK	63.03	12.68	3.40	0.99	0.81	0.55	4.43	0.70	0.09
S00240	NAS-0214	3630.	1210102628	3417 SDCK	57.72	15.28	4.46	1.51	0.70	0.69	4.80	0.72	0.02
S00241	NAS-0215	3700.	1210102628	3447 BLCR	41.96	8.60	4.70	4.05	13.73	0.39	3.03	0.40	0.07
S00242	NAS-0216	540.	1210900180	3417 GRCK	53.70	16.06	5.30	2.25	0.66	0.25	6.56	0.78	0.05
S00243	NAS-0219	1330.	1211300333	3417 GRCK	53.10	14.83	6.02	2.07	0.81	0.23	6.17	0.73	0.05
S00244	NAS-0222	570.	1211300067	3397 HNBL	65.17	14.51	4.43	1.94	0.99	0.27	5.05	1.03	<0.01
S00245	NAS-0224	730.	1211300067	3417 GRCK	55.76	16.98	4.99	2.06	0.56	0.26	5.47	0.87	0.05
S00246	NAS-0227	890.	1211300357	3417 GRCK	54.60	16.85	5.47	2.34	0.39	0.30	6.22	0.80	0.07
S00247	NAS-0229	470.	1214700040	3417 GRCK	52.76	16.04	5.12	2.30	0.84	0.29	5.98	0.77	0.15
S00248	NAS-0233	1700.	1216722304	3417 GRCK	56.65	15.68	5.08	2.27	0.74	0.49	5.87	0.83	0.07
S00249	NAS-0234	1355.	1216701441	3417 GRCK	53.08	14.53	4.99	2.79	1.90	0.37	6.31	0.75	<0.01
S00250	NAS-0237	1090.	1218301848	3417 GRCK	55.35	16.66	4.61	2.69	1.48	0.28	5.75	0.80	0.09
S00251	NAS-0240	540.	1218301845	3417 GRCK	53.53	13.57	6.00	2.47	1.78	0.32	5.67	0.72	0.05
S00252	NAS-0242	620.	1218301825	3417 GRCK	54.13	14.83	5.40	2.66	1.44	0.34	5.82	0.72	0.05
S00253	NAS-0246	4650.	1219307815	3417 GRCK	59.95	10.24	5.51	1.34	2.20	0.63	3.54	0.58	0.14
S00254	NAS-0247	4750.	1219307815	3417 GCSC	64.29	11.71	5.21	1.19	0.67	0.63	3.26	0.53	0.02
S00255	NAS-0249	4890.	1219307815	3447 BLCR	45.57	9.07	3.63	3.45	11.84	0.59	2.92	0.42	0.05
S00256	NAS-0252	4410.	1219902531	3417 GRCK	59.82	15.60	5.15	1.82	0.97	0.74	4.85	0.77	0.09
S00257	NAS-0253	4510.	1219902531	3417 SDCK	62.34	12.94	3.77	2.04	1.65	0.69	4.42	0.67	0.05
S00269	NAS-0292	2070.	1200500484	3417 GRCK	59.11	13.91	5.00	1.81	1.26	0.61	3.99	0.67	0.02
S00270	NAS-0295	450.	1201900307	3417 SDCK	56.35	15.17	5.00	2.30	1.02	0.26	4.65	0.83	0.07
S00271	NAS-0298	580.	1201901323	3417 GRCK	54.21	15.89	6.02	2.01	0.69	0.24	5.13	0.83	0.07
S00272	NAS-0300		1201900630	3347 WRSW	55.11	15.27	5.34	2.42	1.64	0.22	4.74	0.82	0.07
S00273	NAS-0307	1280.	1202301492	3417 GRCK	55.11	14.06	6.05	1.57	1.36	0.56	4.34	0.75	0.07

Table C1. Continued.

Sample no.	Geol. no.	Depth to top (ft)	Location (API no.)	Formation code	SiO_2 (%)	Al_2O_3 (%)	Fe as FeO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)
S00274	NAS-0309	4230.	1202505028	3417 GRCK	56.03	13.66	5.11	1.87	1.50	0.68	4.30	0.75	0.05
S00275	NAS-0314	2125.	1202902104	3417 GRCK	56.94	13.62	5.25	1.97	1.08	0.46	4.48	0.75	0.07
S00276	NAS-0317	1110.	1203900091	3417 GRCK	54.09	15.87	5.25	1.96	0.95	0.30	4.81	0.88	0.07
S00277	NAS-0320	2410.	1204121220	3417 GCSC	54.47	14.30	5.65	1.86	0.90	0.44	4.47	0.78	0.05
S00278	NAS-0322	995.	1204100352	3417 GRCK	57.55	11.60	5.84	1.92	1.78	0.54	3.61	0.67	0.11
S00279	NAS-0325	3340.	1205124969	3417 GRCK	61.28	12.71	5.39	1.44	0.55	0.67	4.24	0.80	0.02
S00280	NAS-0331	3455.	1205101748	3417 GRCK	54.24	15.85	5.38	1.99	2.66	0.68	4.17	0.72	0.05
S00281	NAS-0335	4590.	1205501572	3417 GRCK	58.88	14.51	5.15	1.97	1.33	0.74	4.37	0.78	0.05
S00282	NAS-0338	4500.	1205502641	3417 SDCK	56.50	16.15	4.70	1.96	1.30	0.76	4.65	0.82	0.07
S00283	NAS-0343	4830.	1205501986	3417 GRCK	63.41	11.52	4.23	1.48	1.51	0.49	4.02	0.62	0.02
S00284	NAS-0346	3285.	1207701495	3417 GRCK	58.77	14.02	3.96	2.17	3.50	0.53	4.62	0.73	0.07
S00285	NAS-0348	3240.	1207701511	3417 GRCK	53.29	12.81	5.12	1.99	2.18	0.56	4.05	0.63	0.02
S00286	NAS-0351	1735.	1207701440	3417 GRCK	55.13	13.91	5.08	2.45	2.49	0.42	4.64	0.68	0.07
S00287	NAS-0355	4450.	1208123131	3417 GRCK	58.96	12.94	5.25	1.72	1.65	0.72	4.06	0.75	0.09
S00288	NAS-0359	2170.	1208720285	3417 GRCK	60.55	14.15	5.48	1.89	0.99	0.72	4.32	0.65	0.02
S00289	NAS-0360	2300.	1208720285	3417 SDCK	55.46	15.15	5.02	2.20	1.32	0.71	4.89	0.78	0.07
S00290	NAS-0361	455.	1209500605	3417 GRCK	53.12	16.95	5.00	2.40	0.50	0.24	5.33	0.87	0.07
S00291	NAS-0366	2090.	1211521101	3417 GRCK	55.86	15.23	5.04	2.27	1.30	0.63	4.88	0.83	0.05
S00292	NAS-0369	1500.	1211700920	3417 GRCK	53.27	12.71	5.92	2.60	1.75	0.48	4.55	0.70	0.09
S00293	NAS-0370	3720.	1212105712	3417 GRCK	54.21	13.23	5.22	1.86	1.55	0.61	4.36	0.70	0.05
S00294	NAS-0377	2070.	1213521827	3417 GRCK	60.35	14.10	4.55	1.46	1.31	0.66	4.21	0.73	0.06
S00295	NAS-0380	1730.	1213500347	3417 SDCK	55.23	14.23	4.77	1.56	0.95	0.60	4.89	0.70	0.05
S00296	NAS-0383	1010.	1213700346	3417 GRCK	58.17	15.34	5.24	1.92	0.44	0.61	5.02	0.84	0.13
S00297	NAS-0389	1220.	1214700207	3417 GRCK	55.36	16.59	5.71	2.17	1.36	0.28	5.76	0.76	0.12
S00298	NAS-0393	4360.	1216502400	3417 GRCK	60.90	13.84	5.06	1.12	1.01	0.76	4.20	0.67	0.07
S00299	NAS-0396	4495.	1216502400	3417 SDCK	61.08	12.74	4.56	2.10	2.06	0.70	3.93	0.62	0.03
S00300	NAS-0398	4400.	1216503631	3417 GRCK	65.19	10.96	4.95	1.09	1.22	0.63	3.66	0.55	0.06
S00301	NAS-0402	4530.	1216503631	3417 SDCK	57.24	15.57	4.36	2.63	3.45	0.85	4.46	0.82	0.07
S00302	NAS-0409	3230.	1217322034	3417 GRCK	52.40	15.19	7.01	1.80	1.24	0.51	5.27	0.75	0.03
S00303	NAS-0413	510.	1217900278	3417 GCSC	55.31	17.08	5.38	2.09	0.69	0.30	7.12	0.77	<0.01
S00304	NAS-0415	3165.	1217322024	3417 GRCK	57.60	13.70	5.16	1.75	1.42	0.49	4.65	0.65	0.09
S00305	NAS-0417	2070.	1218100081	3417 GRCK	59.60	14.07	4.80	1.41	1.39	0.70	4.73	0.79	0.10
S00306	NAS-0421	4985.	1219100842	3417 GRCK	59.50	12.48	5.17	1.63	2.65	0.70	3.65	0.63	0.14
S00307	NAS-0424	5090.	1219100842	3417 SDCK	58.09	14.66	4.71	2.07	2.38	0.75	4.23	0.70	0.04
S00308	NAS-0427	5030.	1219308296	3417 GRCK	67.47	10.83	3.21	0.77	0.71	0.65	3.33	0.64	0.08
S00309	NAS-0431	5200.	1219308296	3417 SDCK	58.85	12.57	6.73	1.71	1.69	0.71	3.73	0.62	0.07
S00310	NAS-0434	1055.	16055	3417 GRCK	63.78	11.36	4.59	0.82	2.02	0.54	3.70	0.54	0.06
S00311	NAS-0438	1315.	16055	3417 SDCK	45.11	9.20	3.19	2.48	15.69	0.47	2.48	0.43	0.07
S00312	NAS-0444	2220.	1202704018	3417 SDCK	56.97	17.39	4.92	2.47	0.84	0.78	4.89	0.78	0.09
S00313	NAS-0447	4220.	1207901522	3417 GRCK	61.99	12.48	4.57	1.99	2.19	0.53	3.94	0.63	0.05
S00314	NAS-0451	4325.	1207901522	3417 SDCK	54.33	14.17	4.71	2.85	4.27	0.65	4.09	0.67	0.05
S00315	NAS-0454	835.	1212500004	3417 GCSC	55.56	18.62	5.47	2.19	0.97	0.24	5.24	0.84	0.12
S00316	NAS-0459	1795.	1213500702	3417 GRCK	51.22	12.17	10.71	1.51	0.49	0.63	4.15	0.66	0.03
S00317	NAS-0460	500.	1214300468	3417 GCSC	55.69	17.80	5.57	2.43	0.83	0.26	5.04	0.89	0.07
S00318	NAS-0464	388.	1214900007	3417 GCSC	58.21	16.48	5.83	2.41	0.68	0.30	4.69	0.87	0.06
S00319	NAS-0466	340.	1214900164	3417 GRCK	58.83	16.69	4.96	2.07	0.41	0.32	4.94	0.90	0.05
S00320	NAS-0470	360.	1216900332	3417 GCSC	60.84	14.72	5.57	2.13	0.91	0.35	4.59	0.91	0.09
S00321	NAS-0473	5210.	1219328436	3417 GRCK	59.79	14.48	5.95	1.68	1.89	0.68	3.87	0.64	0.09
S00322	NAS-0476	5330.	1219328436	3447 BLCR	39.36	7.04	2.48	4.56	18.80	0.45	2.27	0.31	0.10

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	SA-CO_2 (m^2/g)	SA-N_2 (m^2/g)
S00001	01KY01C1	4.67	0.02	0.38	14.03	0.064	1.78	0.42	96.02	4.96	0.06	1.93	14.13	39.3	1.5
S00002	01KY02C1	4.32	0.02	2.08	9.78	0.063		0.40	96.68	3.81	0.04	1.21	10.35	27.0	1.3
S00003	01KY03C1	5.02	0.01	2.76	6.62	0.050	1.12	0.45	95.82	4.94	0.05	0.97	7.37	20.4	1.3
S00004	01KY04C1	0.91	0.02	2.20	1.64	0.090	4.18	0.67	98.92	0.78		0.74	2.24	13.8	5.0
S00005	01KY05C1	5.30	0.02	4.40	5.81	0.29	1.49	0.41	99.39	5.12	0.11	0.91	7.01	13.8	1.0
S00006	01KY06C1	0.76	0.02	3.77	0.66	0.090	3.98	0.59	98.84	0.64		0.59	1.69	14.5	8.7
S00007	01KY07C1	4.19	0.01	1.14	11.95	0.075	0.91	0.75	97.09	3.54	0.05	1.62	12.26	31.3	1.5
S00008	01KY08C1	1.24	0.02	3.52	5.04	0.089	5.80	0.32	102.08	1.07		1.29	6.00	11.8	1.4
S00033	01KY08L1	2.45	0.01	3.01	7.72	0.095	1.14	0.68	99.06	2.34		1.13	8.54	14.9	1.1
S00009	01KY09C1	1.56	0.01	7.24	5.53	0.077	3.41	0.49	98.44	1.58	0.02	1.10	7.51	11.1	1.1
S00034	01KY10L1	1.21	0.01	8.24	3.40	0.088	2.58	0.48	99.49	1.09		0.75	5.65	7.1	0.9
S00010	01KY10C1	1.45	0.01	4.87	9.23	0.080	2.26	0.17	97.76	1.30		1.38	10.56	14.7	1.1
S00035	01KY11L1	2.07	0.02	6.96	6.74	0.077	1.60	0.38	97.82	1.71		1.03	8.64	10.6	0.9
S00011	01KY11C1	2.77	0.02	10.00	7.38	0.087	1.34	0.31	97.44	2.85	0.04	1.07	10.11	12.7	0.9
S00012	01KY12C1	2.41	0.01	9.71	5.67	0.092	3.08	0.31	100.01	2.21	0.04	1.06	8.32	10.0	1.0
S00036	01KY12L1	1.95	0.01	11.42	5.70	0.097	1.41	0.34	99.55	1.70		0.88	8.82	8.6	0.9
S00037	01KY13L1	2.24	0.01	10.99	5.93	0.086	0.89	0.35	98.02	1.83		0.85	8.93	9.7	1.0
S00013	01KY13C1	2.17	0.01	12.33	7.71	0.092	0.13	0.36	98.38	2.13	0.04	0.98	11.08	14.3	0.8
S00393	02KY01C1	5.80	0.01	0.30	13.96	0.083	2.80	0.88	96.32	5.61	0.21	1.78	14.04	48.1	8.1
S00394	02KY02C1	5.57	0.02	1.35	15.55	0.065	2.91	0.54	97.05	5.60	0.052	1.91	15.92	53.0	6.4
S00395	02KY03C1	2.74	0.01	1.21	5.95	0.071	3.01	0.63	99.34	2.71	<0.005	0.99	6.28	26.3	10.9
S00396	02KY04C1	1.81	0.01	2.50	6.01	0.096	3.18	0.40	99.27	1.78	<0.005	0.99	6.69	25.8	10.1
S00397	02KY05C1	2.24	0.01	1.86	5.82	0.091	3.52	0.59	98.00	2.17	0.014	1.03	6.33	27.4	11.2
S00398	02KY06C1	6.97	0.01	3.08	4.38	0.089	2.81	0.59	97.90	6.64	0.029	0.81	5.22	21.7	10.1
S00399	02KY07C1	2.40	0.02	2.07	5.50	0.11	3.57	0.46	99.29	2.31	<0.005	0.99	6.07	26.1	11.4
S00400	02KY08C1	1.90	0.02	4.36	9.32	0.11	3.24	0.48	98.54	1.76	0.012	1.33	10.51	27.7	4.7
S00401	02KY09C1	1.38	0.02	11.99	8.97	0.12	2.95	0.37	101.13	1.21	0.007	1.25	12.24	24.4	4.7
S00014	01IL01L2	0.09	0.13	1.65	0.43	0.092	1.92	4.32	97.49	0.16		0.75	0.88	27.3	27.4
S00015	01IL03L1	0.13	0.08	2.44	0.29	0.081	0.40	3.22	99.38	0.09		0.44	0.96	12.7	12.1
S00016	01IL04L1	0.27	0.14	0.62	0.80	0.038	0.95	2.48	98.01	0.21		0.48	0.97	11.8	11.8
S00017	01IL05L1	0.32	0.11	0.59	0.30	0.051	2.39	1.94	96.86	0.27		0.52	0.46	16.6	17.8
S00018	01IL07L1	0.15	0.04	13.67	0.15	0.057	1.68	1.38	101.06	0.10		0.36	3.88	10.1	8.4
S00019	01IL09L1	0.29	0.12	1.58	0.32	0.056	1.42	4.14	99.32	0.28		0.66	0.75	22.8	23.5
S00020	01IL09L2	0.97	0.12	0.33	0.58	0.061	4.22	0.70	97.80	0.94		0.62	0.67	23.3	23.4
S00021	01IL10L1	2.43	0.09	0.07	1.28	0.060	4.62	0.98	99.21	1.70		0.78	1.30	16.4	12.6
S00022	01IL11L1	0.56	0.10	0.11	2.90	0.097	3.88	1.14	96.28	0.34		0.91	2.93	30.2	20.3
S00023	01IL12L1	0.52	0.12	0.59	1.64	0.083	4.43	1.14	99.78	0.42		0.82	1.80	30.8	25.7
S00024	01IL13L1	0.54	0.14	0.29	2.76	0.094	5.60	1.18	101.66	0.53		1.09	2.84	31.2	25.7
S00025	01IL14L1	1.51	0.12	0.29	4.25	0.082	4.24	1.30	96.95	1.16		1.13	4.33	31.5	19.0
S00026	01IL15L1	1.95	0.09	0.24	7.54	0.095	3.95	1.28	98.61	1.27	0.56	1.49	7.61	34.4	11.8
S00027	01IL16L1	2.84	0.09	0.55	9.22	0.068	1.91	1.16	97.77	2.36	0.42	1.45	9.37	34.0	8.3
S00028	01IL17L1	2.10	0.09	0.18	6.52	0.10	1.89	1.48	97.58	1.14	0.77	1.16	6.57	25.9	5.5
S00029	01IL18L1	1.53	0.09	0.20	5.17	0.064	2.86	1.16	96.66	0.64		1.07	5.22	20.5	6.0
S00030	01IL19L1	2.80	0.10	0.48	6.02	0.087	3.09	1.27	97.51	2.06	0.59	1.21	6.15	25.1	6.2
S00031	01IL20L1	1.87	0.09	2.82	3.09	0.081	4.29	0.80	97.97	1.57		0.94	3.86	19.3	11.5
S00032	01IL21L1	1.60	0.11	0.99	3.79	0.11	5.59	0.53	98.26	2.05		1.14	4.06	22.6	11.5
S00038	02IL01L2	0.09	0.08	36.72	0.36	0.023	1.60	0.25	101.35	0.03		0.25	10.38	4.7	5.1
S00051	02IL01C1	0.75	0.12	0.02	1.61	0.083	4.19	1.32	102.63	0.73		0.81	1.62	18.9	15.7
S00052	02IL02C1	0.40	0.08	0.16	2.37	0.073	1.58	1.06	99.04	0.45		0.58	2.41	10.7	8.0

Table C1. Continued.

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	$SA-CO_2$ (m^2/g)	$SA-N_2$ (m^2/g)
S00053	02IL03C1	2.56	0.05	1.52	6.64	0.085	1.66	1.14	99.51	2.50	0.04	1.11	7.05	21.6	1.9
S00054	02IL04C1	4.13	0.05	0.95	8.51	0.090	3.36	1.01	102.10	4.05	0.01	1.51	8.77	21.5	1.9
S00055	02IL04C2	2.60	0.05	3.04	8.45	0.090	0.48	1.09	98.79	2.60	0.02	1.19	9.28	23.9	2.3
S00056	02IL05C1	2.89	0.04	0.88	9.21	0.090	1.85	0.96	99.78	2.75	0.04	1.42	9.45	11.9	2.1
S00039	02IL05L2	1.22	0.07	1.94	2.54	0.096	3.27	0.80	101.71	1.19	<0.001	0.76	3.07	12.0	4.2
S00057	02IL06C1	2.01	0.04	0.48	7.12	0.088	1.89	1.02	97.94	1.91	0.02	1.18	7.25	19.4	2.3
S00040	02IL06L2	0.90	0.06	1.25	2.60	0.10	3.58	0.69	102.34	0.82	<0.001	0.79	2.94	9.4	4.6
S00058	02IL07C1	1.76	0.05	0.90	4.22	0.085	4.42	1.06	99.62	1.85	0.03	1.12	4.47	12.1	5.3
S00059	02IL08C1	1.91	0.06	0.70	6.17	0.11	1.12	1.38	98.88	1.92	0.01	1.02	6.36	22.8	6.0
S00041	02IL09L1	0.12	0.08	22.53	0.34	0.11	2.26	0.15	102.16	0.08		0.31	6.49	0.2	0.2
S00042	03IL01L1	0.37	0.01	18.58	0.86	0.057	4.90	0.70	101.83	0.32		0.73	5.93		
S00043	03IL07L1	3.68	0.02	1.96	9.41	0.050	0.16	0.30	98.48	3.29		1.18	9.94		
S00044	03IL12L1	2.17	0.02	1.69	8.52	0.082	0.91	0.50	99.90	2.01		1.18	8.98		
S00045	03IL20L1	0.90	0.05	3.96	1.64	0.11	3.46	0.95	103.19	0.83		0.69	2.72		
S00046	03IL20L3	0.74	0.05	8.06	3.51	0.087	2.34	0.87	101.55	0.72		0.76	5.71		
S00047	03IL23L1	3.06	0.05	4.36	7.11	0.12	0.66	0.56	100.86	2.53		0.99	8.30		
S00048	03IL26L1	1.28	0.03	4.93	7.87	0.19	1.17	0.48	100.33	1.03	0.01	1.13	9.22		
S00096	04IL01C1	0.69	0.01	5.68	0.55	0.12	7.48	0.69	102.16	0.70	0.01	0.98	2.10	37.8	38.9
S00097	04IL02C1	0.66	0.01	6.44	0.68	0.091	6.52	0.62	101.77	0.68	<0.001	0.88	2.44	34.4	35.8
S00098	04IL03C1	0.53	0.01	9.38	0.49	0.086	4.08	0.58	98.90	0.55	<0.005	0.58	3.05	32.8	32.7
S00099	04IL04C1	0.48	0.01	6.96	0.65	0.095	4.26	0.67	98.80	0.59	<0.005	0.63	2.55	34.7	37.4
S00100	04IL05C1	1.33	0.01	9.09	0.84	0.069	4.04	0.60	98.04	1.34	<0.005	0.62	3.32	31.5	33.4
S00101	04IL06C1	0.87	0.01	6.99	0.95	0.083	3.18	0.63	97.44	0.96	0.01	0.54	2.86	33.0	34.3
S00102	04IL07C1	0.85	0.01	6.44	0.65	0.090	2.97	0.80	97.10	1.06	0.01	0.50	2.41	38.9	38.8
S00103	04IL08C1	0.85	0.01	6.78	0.82	0.070	5.84	0.70	102.10	0.91	<0.001	0.83	2.67	37.1	37.2
S00104	04IL09C1	0.44	0.01	5.17	0.95	0.10	4.55	0.69	99.46			0.70	2.36	36.4	37.6
S00105	04IL10C1	0.45	0.01	4.25	0.74	0.097	3.77	0.80	97.24	0.59	<0.001	0.60	1.90	45.4	42.1
S00106	04IL11C1	1.80	0.01	6.04	1.45	0.094	2.90	0.64	102.58	1.61	<0.005	0.57	3.10	38.9	36.5
S00107	04IL12C1	0.62	0.01	5.75	0.91	0.096	3.55	0.66	98.51	0.58	<0.005	0.58	2.48	34.2	34.5
S00108	04IL13C1	0.76	0.01	4.07	2.01	0.10	3.72	0.56	97.23	0.69	<0.005	0.72	3.12	37.2	34.6
S00109	04IL14C1	1.64	0.01	4.24	2.96	0.099	2.69	0.57	98.57	1.39	<0.005	0.72	4.12	35.1	31.2
S00110	04IL15C1	0.86	0.01	0.84	1.83	0.079	3.73	0.38	97.02	0.88	0.01	0.68	2.06	21.3	20.0
S00111	04IL16C1	0.73	0.01	1.58	2.75	0.085	4.10	0.46	98.35	0.79	<0.005	0.84	3.18	24.4	19.4
S00159	04IL17L1	1.05	0.01	2.31	3.01	0.077	2.18	0.58	97.81	1.16	<0.001	0.67	3.64		
S00112	04IL17C1	0.97	0.01	1.58	3.55	0.087	1.76	0.51	97.40	0.94	0.02	0.68	3.98	23.5	16.7
S00113	04IL18C1	0.64	0.01	0.77	0.61	0.069	7.88	0.40	101.90			1.00	0.82	20.3	20.8
S00114	04IL19C1	0.28	0.01	1.28	0.57	0.069	4.43	0.59	96.74			0.63	0.92	20.1	19.3
S00160	04IL19L1	0.74	0.02	1.24	3.24	0.082	4.20	0.81	99.74	0.76	0.02	0.95	3.58		
S00115	04IL20C1	1.32	0.01	1.24	5.31	0.077	4.60	0.43	97.53	1.27	0.01	1.20	5.65	26.4	17.0
S00116	04IL21C1	0.82	0.01	2.13	1.22	0.084	4.47	0.39	96.59	0.88	0.01	0.69	1.80	24.2	21.3
S00117	04IL22C1	1.25	0.01	2.44	2.26	0.094	3.25	0.40	97.72	1.26	0.01	0.68	2.93	24.6	20.2
S00118	04IL23C1	1.44	0.01	1.94	1.87	0.097	4.27	0.43	98.71	1.40	0.02	0.75	2.40	22.7	20.0
S00119	04IL24C1	0.95	0.01	4.25	2.18	0.098	4.76	0.41	99.07	0.92	0.02	0.84	3.34	22.6	19.3
S00120	04IL25C1	0.74	0.01	6.12	1.69	0.096	3.74	0.52	99.94	0.73	0.01	0.68	3.36	23.1	20.2
S00121	04IL26C1	2.09	0.01	1.83	2.84	0.10	2.50	0.53	98.38	2.05	<0.005	0.68	3.34	21.9	19.1
S00161	04IL27L1	0.99	0.01	15.91	0.06	0.10	2.92	0.68	101.00	0.99	<0.001	0.41	4.40		
S00122	04IL27C1	0.84	0.01	23.12	0.60	0.084	2.70	0.32	97.73	0.80	0.03	0.41	6.91	14.5	14.1
S00123	04IL28C1	0.72	0.01	19.82	0.55	0.087	2.08	0.37	97.15	0.68	0.02	0.34	5.96	18.2	17.7
S00162	04IL29L1	1.45	0.01	23.55	0.22	0.056	2.06	0.39	98.72	1.50	0.06	0.30	6.65		

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	SA-CO_2 (m^2/g)	SA-N_2 (m^2/g)
S00124	04IL29C1	1.19	0.01	28.36	0.82	0.031	3.55	0.13	102.38	1.13	0.05	0.51	8.56	6.3	6.5
S00125	04IL30C1	0.50	0.01	38.03	0.32	0.036	2.34	0.18	99.81	0.47	0.04	0.32	10.70	6.7	7.3
S00172	05IL01L1	3.04	0.03	1.65	4.74	0.12	4.29	0.81	97.75	2.98	0.07	1.14	5.19	25.7	12.9
S00173	05IL01L2	2.32	0.02	1.17	4.39	0.12	4.50	0.89	97.88	2.24	0.07	1.13	4.71	28.4	15.9
S00174	05IL01L3	3.46	0.02	1.69	4.99	0.13	3.51	0.87	97.10	3.34	0.04	1.09	5.45	29.0	16.5
S00073	06IL04C1	0.29	0.02	5.90	0.57	0.069	4.11	0.64	99.63	0.48	0.01	0.60	2.18	29.0	27.7
S00074	06IL05C1	0.18	0.02	2.53	0.32	0.078	4.26	0.76	97.92	0.29	0.01	0.60	1.01	29.9	31.8
S00075	06IL06C1	0.57	0.02	6.34	0.65	0.077	4.24	0.60	99.78	0.71	0.02	0.62	2.38	28.2	29.1
S00076	06IL07C1	0.39	0.02	6.49	0.49	0.060	3.67	0.63	98.33	0.47	0.02	0.54	2.26	24.3	24.8
S00077	06IL08C1	1.65	0.02	3.63	1.09	0.083	2.75	0.73	96.63	1.62	0.02	0.52	2.08	29.2	31.8
S00078	06IL09C1	0.29	0.02	3.96	0.22	0.092	5.82	0.70	99.38	0.31	0.02	0.76	1.33	29.7	31.7
S00079	06IL10C1	0.51	0.02	3.55	0.73	0.054	3.05	0.72	97.15	0.59	0.03	0.51	1.70	31.6	33.3
S00080	06IL11C1	0.68	0.02	2.23	0.99	0.080	6.80	0.54	100.62	0.67	0.02	0.94	1.60	32.5	32.8
S00163	06IL11L1	0.78	0.02	8.06	0.49	0.072	5.16	0.66	102.06	0.84	<0.001	0.71	2.69	27.9	27.2
S00081	06IL12C1	0.50	0.02	2.16	0.97	0.078	5.89	0.58	96.57	0.57	0.02	0.84	1.56	34.3	32.8
S00082	06IL13C1	0.64	0.02	4.34	0.90	0.085	3.65	0.57	102.57	0.67	0.01	0.58	2.08	35.2	33.7
S00164	06IL13L1	0.52	0.02	3.08	1.34	0.095	2.94	0.90	98.98	0.64	<0.005	0.59	2.18	35.6	35.4
S00165	06IL13L2	0.98	0.02	0.95	1.74	0.092	3.97	2.39	100.43	1.04	<0.005	0.92	2.00	39.8	34.5
S00166	06IL14L1	0.80	0.02	7.25	0.97	0.085	2.48	0.95	97.72	0.83	<0.001	0.50	2.95	33.3	33.4
S00083	06IL14C1	0.90	0.02	3.41	0.85	0.075	4.48	0.86	98.26	0.84	0.01	0.70	1.78	39.2	39.3
S00084	06IL15C1	0.91	0.02	2.73	1.45	0.083	3.24	0.57	98.70	0.93	0.02	0.60	2.20	36.0	33.5
S00085	06IL16C1	0.72	0.02	3.85	1.13	0.084	2.82	0.70	97.61	0.85	0.01	0.53	2.18	37.1	36.3
S00086	06IL17C1	1.70	0.02	4.85	2.46	0.083	2.54	0.54	98.97	1.58	0.01	0.64	3.78	30.9	27.2
S00087	06IL18C1	1.16	0.02	1.32	4.14	0.092	6.76	0.78	99.55	1.02	0.01	1.34	4.50	33.7	25.8
S00088	06IL19C1	2.05	0.02	0.95	6.11	0.076	3.71	0.64	97.97	1.86	0.02	1.22	6.37	37.6	23.1
S00167	06IL19L1	3.01	0.01	0.11	7.58	0.087	0.69	0.74	97.63	3.15	0.03	1.07	7.61	35.3	14.8
S00089	06IL20C1	3.72	0.02	0.48	10.20	0.074	1.55	0.56	96.66	3.34	0.02	1.46	10.33	38.0	13.1
S00168	06IL21L1	5.61	0.01	2.13	4.89	0.085	4.26	0.51	96.17	5.24	0.03	1.12	5.47	23.3	10.3
S00090	06IL21C1	2.20	0.01	0.29	5.69	0.079	2.84	0.71	96.26	2.08	0.02	1.08	5.77	25.0	13.7
S00169	06IL22L1	1.19	0.01	0.51	3.06	0.090	5.00	0.57	98.48	1.22	<0.001	0.99	3.20	23.0	14.8
S00091	06IL22C1	1.57	0.01	0.37	3.82	0.084	3.38	0.57	98.70	1.22	0.01	0.90	3.92	21.1	13.3
S00092	06IL23C1	1.87	0.01	1.28	3.63	0.095	2.29	0.61	96.77	1.61	0.02	0.76	3.98	23.7	16.5
S00093	06IL24C1	1.11	0.01	6.30	1.08	0.080	2.97	0.52	99.01	1.00	0.02	0.52	2.80	20.0	18.4
S00170	06IL25L1	1.26	0.01	3.11	0.94	0.11	4.38	0.69	98.21	1.36	<0.001	0.68	1.79	24.0	21.6
S00094	06IL25C1	1.79	0.01	1.72	2.81	0.10	3.63	0.51	100.86	1.54	0.02	0.80	3.28	25.8	18.0
S00171	06IL25L2	3.40	0.02	21.07	1.52	0.086	1.36	0.32	96.51	3.14	0.01	0.37	7.27	7.9	6.1
S00126	07IL01L1	0.06	0.05	38.80	0.14	0.017	1.10	0.18	96.72			0.16	10.73		
S00127	07IL01L2	0.44	0.07	<0.04	5.98	0.12	2.12	0.40	96.46	0.49	0.06	1.00	5.99		
S00128	07IL01L3	0.32	0.06	10.99	0.64	0.084	3.49	0.65	100.45			0.54	3.64		
S00129	07IL02L1	0.75	0.09	0.07	2.20	0.086	2.79	0.93	100.56	0.38	0.08	0.68	2.22		
S00130	07IL02L2	1.40	0.06	24.59	0.91	0.058	1.56	0.50	97.44	1.34	0.10	0.34	7.62		
S00131	07IL03L1	0.35	0.10	<0.04	2.53	0.088	2.47	0.80	101.60	0.34	0.07	0.67	2.54		
S00132	07IL04L1	3.13	0.04	0.84	6.74	0.10	1.92	0.86	98.19	2.93	0.10	1.12	6.97		
S00133	07IL04L2	3.55	0.04	0.68	5.39	0.10	3.16	0.98	97.35	3.19	0.09	1.11	5.58		
S00134	07IL05L1	0.55	0.11	11.97	0.31	0.015	1.70	0.20	100.67	0.52	0.07	0.25	3.58		
S00135	09IL01L3	1.87	0.03	0.40	9.53	0.096	3.40	0.86	98.25	1.66	0.12	1.62	9.64		
S00323	10IL01L1	2.51	0.04	1.36	6.67	0.10	2.47	0.83	98.81	2.47	0.05	1.17	7.04	28.1	5.7
S00324	10IL01L2	2.06	0.04	3.62	5.75	0.12	2.70	0.87	101.70	1.91	0.01	1.09	6.74	25.3	6.7
S00325	10IL01L3	2.29	0.04	4.47	0.87	0.074	1.25	0.32	100.58	2.15	0.01	0.28	2.09	5.7	5.3

Table C1. Continued.

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	$SA-CO_2$ (m^2/g)	$SA-N_2$ (m^2/g)
S00326	10IL01L4	1.10	0.04	28.15	1.65	0.056	1.25	0.11	99.38	1.02	0.02	0.35	9.33	7.9	3.6
S00327	10IL01L5	0.86	0.03	18.54	0.67	0.061	1.20	0.14	103.06	0.77	0.01	0.23	5.73	3.5	1.8
S00328	10IL01L6	1.59	0.04	24.18	1.69	0.077	1.67	0.45	100.54	1.52	0.01	0.44	8.29	11.2	5.2
S00329	10IL01L7	0.30	0.03	12.23	0.26	0.012	0.91	0.06	102.42			0.14	3.60	0.4	0.3
S00330	11IL02C1	2.90	0.01	0.27	5.77	0.15	3.33	0.36	102.54	2.76	0.09	0.80	5.84	18.4	6.5
S00331	11IL03C1	3.14	0.01	2.63	4.41	0.74	1.58	0.15	101.86	2.99	0.01	0.49	5.13	10.8	2.6
S00377	11IL04L1	2.52	0.01	4.43	4.37		1.58	0.09	102.33	2.45	0.020	0.48	5.58		
S00378	11IL04L*	4.22	0.01	20.12	1.91	0.27	1.47	0.15	99.03	4.18	0.056	0.31	7.40		
S00332	11IL04C1	2.05	0.01	4.69	5.86	0.041	1.21	0.10	101.16	2.05	<0.005	0.54	7.14	13.6	2.5
S00333	11IL05C1	1.38	0.01	4.58	0.70	0.53	2.82	0.16	103.18	1.29	<0.005	0.38	1.95	5.3	4.2
S00334	11IL06C1	2.01	0.01	6.01	1.23	0.25	1.87	0.07	102.48	1.93	0.02	0.30	2.87	3.8	2.0
S00335	11IL07C2	0.67	0.01	4.23	0.50	0.35	3.80	0.28	102.29	0.67	0.02	0.49	1.65	8.5	7.6
S00336	11IL08C1	0.74	0.01	5.72	0.54	0.26	3.27	0.25	102.30	0.65	0.02	0.43	2.10	7.6	6.2
S00337	11IL09C1	1.45	0.02	13.03	1.01	0.045	1.31	0.05	99.92	1.43	0.05	0.22	4.57	3.2	0.8
S00338	11IL10C1	1.05	0.01	6.05	1.28	0.014	1.00	0.11	100.52	0.96	0.01	0.21	2.93	3.4	0.8
S00379	11IL10L1	1.17	0.02	15.76	0.63	0.17	1.33	0.08	98.61	1.16	<0.005	0.20	4.93		
S00339	11IL11C1	0.81	0.01	7.47	1.30	0.17	1.58	0.14	101.10	0.76	0.01	0.28	3.34	4.3	2.5
S00380	11IL11L1	0.62	0.01	9.45	1.16	0.31	1.21	0.06	101.53	0.55	0.007	0.22	3.74		
S00340	11IL12C1	1.70	0.01	5.55	3.26	0.030	0.41	0.14	100.01	1.69	<0.001	0.28	4.77	7.5	2.4
S00381	11IL12L1	0.99	0.01	10.78	2.05	0.032	1.48	0.06	101.07	0.95	0.007	0.31	4.99		
S00341	11IL13C1	2.79	0.01	4.13	5.08	0.11	2.53	0.14	101.54	2.72	0.02	0.64	6.21	11.4	1.9
S00342	11IL14C1	1.83	0.01	5.02	2.84	0.14	1.64	0.14	102.30	1.72	<0.001	0.39	4.21	7.2	2.0
S00343	11IL15C1	1.80	0.01	3.23	6.50	0.091	1.26	0.12	100.59	1.83	<0.005	0.59	7.38	15.2	2.2
S00344	11IL16C1	1.55	0.01	4.64	3.65	0.017	0.45	0.13	100.66	1.49	<0.001	0.31	4.92	9.9	2.1
S00345	11IL17C1	1.33	0.01	5.65	2.65	0.19	1.64	0.17	101.11	1.24	0.01	0.38	4.19	8.1	2.3
S00346	11IL17C2	5.00	0.01	3.91	3.40	0.054	0.73	0.09	99.53	4.57	0.04	0.32	4.47	8.2	2.1
S00347	11IL18C1	0.91	0.01	4.71	1.81	0.37	1.56	0.13	100.22	0.80	0.01	0.31	3.10	5.6	2.0
S00348	11IL19C1	0.87	0.01	4.86	2.89	0.44	0.54	0.05	102.37	0.67	<0.005	0.26	4.22	6.6	1.6
S00349	11IL20C1	2.37	0.01	5.80	3.41	1.17	0.83	0.07	102.31	1.98	0.02	0.33	4.99	10.3	1.7
S00350	11IL21C1	1.29	0.01	10.65	0.43	0.081	2.12	0.04	100.06	1.15	<0.005	0.27	3.34	7.0	1.9
S00402	12IL01C1	3.01	0.04	<0.03	9.38	0.12	0.91	0.39	96.73	2.96	0.029	1.27	9.38	19.0	1.5
S00403	12IL01C2	1.52	0.04	0.19	5.74	0.11	2.10	0.32	97.66	1.56	0.019	0.96	5.79	10.1	1.4
S00404	12IL01C3	1.05	0.03	1.73	7.80	0.095	0.98	0.31	98.88	0.98	0.012	1.08	8.27	13.8	1.5
S00405	12IL01C4	2.07	0.03	0.49	5.03	0.10	1.17	0.31	97.53	1.93	0.022	0.77	5.17	9.4	1.5
S00407	13IL04C1	0.79	0.05	9.45	0.96	0.071	3.09	0.26	101.03	0.82	0.001	0.49	3.53	12.8	8.8
S00408	13IL05C1	1.06	0.05	0.16	6.63	0.11	1.43	0.30	99.18	1.20	0.001	0.99	6.68	12.6	1.3
S00409	13IL06C2	1.17	0.04	<0.03	5.31	0.091	1.69	0.31	100.43	1.34	0.001	0.86	5.31	10.9	1.7
S00410	13IL07C2	1.66	0.03	3.42	7.15	0.064		0.35	97.78	1.63	0.001	0.89	8.08	14.2	3.2
S00411	13IL08C1	1.31	0.04	0.20	7.04	0.068	0.12	0.28	99.26	1.30	<0.005	0.89	7.09	16.9	3.6
S00412	13IL09C1	4.07	0.03	3.19	8.35	0.081	1.13	0.28	98.18	4.18	<0.005	1.13	9.23	22.3	1.6
S00413	13IL10C1	3.89	0.03	2.83	8.67	0.077	0.01	0.25	97.32	3.85	0.001	1.07	9.44	25.0	1.6
S00414	13IL11C2	4.77	0.04	0.46	7.11	0.067	0.88	0.25	99.33	4.76	0.001	0.98	7.24	19.5	2.5
S00415	13IL12C3	4.27	0.04	0.68	6.20	0.074	2.52	0.23	100.07	4.28	<0.005	1.05	6.38	16.6	2.7
S00416	13IL13C2	3.76	0.04	0.93	6.29	0.052	1.56	0.27	100.02	3.67	0.001	0.96	6.54	15.4	4.1
S00417	13IL14C3	2.71	0.05	1.45	7.72	0.084	1.90	0.28	98.19	2.68	0.001	1.17	8.12	21.2	2.0
S00418	13IL15C2	2.38	0.05	1.39	8.92	0.078	1.95	0.28	99.78	2.38	0.001	1.32	9.30	22.1	1.4
S00419	13IL16C2	2.51	0.04	1.08	6.86	0.096	1.67	0.26	98.17	2.41	0.001	1.04	7.16	19.9	2.0
S00420	13IL17C4	1.83	0.06	6.30	4.35	0.083	3.21	0.26	101.53	1.82	0.001	0.91	6.07	13.5	3.4
S00421	13IL18C2	2.26	0.06	2.41	4.30	0.079	2.02	0.25	99.86	2.23	0.001	0.77	4.96	10.4	2.2

* Sample 11IL04L* is a dike in 11IL04L1.

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	SA-CO_2 (m^2/g)	SA-N_2 (m^2/g)
S00422	13IL19C1	1.40	0.08	5.48	2.23	0.077	2.62	0.18	100.66	1.42	0.001	0.58	3.72	10.2	4.1
S00423	13IL20C1	0.89	0.08	3.32	2.94	0.069	3.71	0.20	102.55	0.99	0.001	0.79	3.85	9.6	1.8
S00424	13IL21C2	1.42	0.06	3.77	4.83	0.092	1.01	0.33	99.00	1.51	0.001	0.73	5.86	11.5	1.3
S00425	13IL22C2	1.00	0.10	2.92	2.26	0.12	4.31	0.24	100.89	0.93	0.001	0.78	3.06	12.5	4.0
S00426	13IL23C4	2.65	0.06	1.58	5.48	0.11	1.80	0.37	99.91	2.54	0.001	0.90	5.91	8.2	1.6
S00427	13IL24C2	1.43	0.06	11.54	3.14	0.090	3.61	0.17	102.94	1.41	0.001	0.80	6.29	4.2	1.0
S00428	13IL25C3	1.04	0.03	20.89	4.00	0.081	0.12	0.15	100.15	1.10	0.001	0.51	9.71	9.7	1.0
S00429	13IL26C3	1.32	0.03	16.43	3.69	0.11	1.11	0.21	101.41	1.33	0.001	0.59	8.18	8.2	1.2
S00430	13IL27C1	1.76	0.03	15.36	3.47	0.13	3.42	0.28	102.38	1.75	0.001	0.83	7.66	7.0	1.1
S00352	01IN01C1	1.30	0.04	0.26	12.96	0.097	0.23	0.53	97.12	1.04	0.014	1.64	13.03	28.0	1.5
S00353	01IN01C2	1.57	0.04	0.54	9.38	0.095	1.04	0.52	99.29	1.41	0.015	1.30	9.53	20.6	1.7
S00354	01IN02C1	1.86	0.04	1.87	7.18	0.094	1.98	0.51	99.10	1.76	0.015	1.14	7.69	17.4	1.9
S00355	01IN03C1	2.34	0.04	2.66	6.78	0.095	1.82	0.56	101.66	2.27	0.013	1.08	7.51	16.6	2.0
S00356	01IN03C2	2.99	0.03	1.93	7.35	0.10	2.18	0.57	100.55	2.78	0.020	1.19	7.88	19.3	1.6
S00357	01IN03C3	4.00	0.03	2.02	9.94	0.087	0.99	0.59	98.18	3.83	0.032	1.37	10.49	26.5	1.6
S00358	01IN04C1	4.91	0.04	0.64	11.69	0.088	0.20	0.49	97.07	4.95	0.036	1.48	11.86	31.3	1.3
S00359	01IN04C2	4.30	0.04	2.77	9.46	0.079	1.43	0.58	98.16	4.29	0.034	1.36	10.22	25.3	1.9
S00360	01IN05C1	2.65	0.04	1.23	8.24	0.095	2.65	0.49	98.51	2.60	0.012	1.34	8.58	16.8	1.5
S00361	01IN05C2	2.03	0.04	1.83	6.58	0.092	3.05	0.53	99.06	2.01	0.016	1.19	7.08	14.0	1.8
S00362	01IN05C3	1.80	0.04	2.14	6.31	0.095	2.88	0.54	99.87	1.72	0.010	1.14	6.89	13.1	1.5
S00363	01IN07C1	1.49	0.05	2.52	2.93	0.11	4.05	0.58	98.91	1.53	<0.005	0.87	3.62	10.9	2.5
S00364	01IN07C2	1.48	0.04	3.11	3.28	0.10	4.02	0.51	100.67	1.47	<0.005	0.90	4.13	11.5	2.5
S00365	01IN08C1	2.22	0.04	2.40	5.18	0.11	2.95	0.43	98.47	2.16	<0.005	1.00	5.84	14.7	1.9
S00366	01IN08C2	2.90	0.04	2.39	7.11	0.10	2.03	0.61	97.81	2.71	<0.005	1.15	7.77	16.2	2.0
S00367	01IN09C1	3.18	0.03	1.94	9.37	0.10	1.09	0.66	98.85	2.88	0.017	1.32	9.90	25.8	1.8
S00368	01IN09C2	1.43	0.05	4.56	2.01	0.11	3.20	0.71	100.53	1.37	0.005	0.68	3.26	10.4	3.9
S00369	01IN10C1	0.80	0.04	32.66	0.50	0.047	1.75	0.22	100.22	0.79	0.016	0.28	9.41	3.3	2.1
S00370	01IN10C2	1.78	0.05	4.54	3.41	0.12	3.14	0.71	101.00	1.69	0.011	0.84	4.65	10.9	2.7
S00371	01IN10C3	2.65	0.04	2.23	6.77	0.11	2.82	0.55	101.06	2.47	0.021	1.19	7.38	16.6	3.4
S00372	01IN11C1	3.18	0.04	2.41	8.88	0.11	2.11	0.61	97.80	3.04	0.023	1.37	9.54	23.4	1.7
S00373	01IN11C2	1.73	0.04	6.34	4.82	0.13	2.69	0.53	99.53	1.66	0.015	0.94	6.56	13.4	1.8
S00374	01IN11C3	2.29	0.03	8.79	5.34	0.13	1.29	0.40	98.17	2.26	0.018	0.83	7.74	13.8	3.4
S00375	01IN13C1	2.50	0.03	9.86	6.30	0.12	1.88	0.48	99.02	2.48	0.024	1.02	8.99	14.7	1.4
S00376	01IN13C2	1.90	0.03	15.85	6.16	0.11	0.90	0.45	100.48	1.76	0.024	0.89	10.49	14.3	1.3
S00049	71477A	0.24	0.01	<0.07	8.81	0.053	1.52	0.92	99.22	0.18		1.33	8.81	40.3	21.5
S00050	71477B	0.07	0.01	<0.07	2.59	0.059	3.09	1.01	101.04	0.07		0.77	2.59	28.3	23.9
S00136	NAS-0021	3.60	0.01	2.05	7.47	0.37	0.39	0.27	101.90			0.97	8.03		
S00137	NAS-0025	3.31	0.01	1.43	7.76	0.090	0.99	0.52	98.25			1.10	8.15		
S00138	NAS-0028	2.60	0.01	1.58	6.07	0.083	1.50	0.66	100.04			0.97	6.50		
S00139	NAS-0031	3.00	0.01	2.93	3.46	0.088	3.49	1.29	97.93			0.95	4.26		
S00140	NAS-0032	1.70	0.01	0.84	5.87	0.095	2.06	0.58	101.01			1.00	6.10		
S00141	NAS-0033	1.97	0.02	1.36	8.32	0.088	0.87	0.57	101.50			1.16	8.69		
S00142	NAS-0036	1.35	0.01	10.08	1.78	0.079	4.19	0.60	99.65			0.75	4.53		
S00143	NAS-0037	1.05	0.01	5.24	1.87	0.10	4.26	0.79	97.38			0.79	3.30		
S00144	NAS-0041	0.42	0.02	2.86	0.53	0.090	4.88	0.72	98.08			0.69	1.31		
S00145	NAS-0043	1.17	0.01	0.67	4.43	0.087	4.14	0.76	99.15			1.08	4.61		
S00146	NAS-0045	1.56	0.01	4.51	4.01	0.075	4.25	0.57	99.87			1.02	5.24		
S00147	NAS-0046	2.17	0.01	3.55	7.09	0.084	3.45	0.48	102.28			1.29	8.06		
S00148	NAS-0050	3.06	0.02	1.30	10.80	0.11	3.37	0.78	97.66			1.76	11.15		

Table C1. Continued.

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	SA-CO_2 (m^2/g)	SA-N_2 (m^2/g)
S00149	NAS-0054	(3.16)	0.02	2.08	7.26	0.082	1.30	0.56	99.39			1.08	7.83		
S00150	NAS-0057	1.55	0.02	0.87	6.97	0.094	1.93	0.42	98.91			1.10	7.21		
S00151	NAS-0059	3.85	0.02	1.6	6.25	0.092	1.69	0.45	97.08			0.99	6.69		
S00152	NAS-0061	1.69	0.01	1.03	5.74	0.092	2.43	0.44	98.83			1.01	6.02		
S00153	NAS-0062	1.48	0.01	4.02	2.58	0.083	4.24	0.32	99.13			0.82	3.68		
S00154	NAS-0065	1.62	0.02	1.69	6.93	0.10	3.08	0.48	100.55			1.23	7.39		
S00155	NAS-0067	2.18	0.01	1.4	6.38	0.084	2.66	0.42	100.97			1.11	6.76		
S00156	NAS-0068	1.02	0.02	16.9	4.11	0.090	2.44	0.30	99.79			0.80	8.72		
S00157	NAS-0070	0.96	0.03	1.6	5.21	0.11	3.96	0.37	100.94			1.11	5.65		
S00158	NAS-0072	1.58	0.01	1.91	4.74	0.096	3.85	0.45	100.66			1.05	5.26		
S00175	NAS-0084	0.46	0.03	0.57	2.26	0.082	6.45	0.69	101.46			1.07	2.42		
S00176	NAS-0087	2.35	0.02	1.39	6.62	0.079	3.87	0.65	96.93			1.30	7.00		
S00177	NAS-0090	3.15	0.02	2.75	7.21	0.076	2.38	0.43	99.59			1.18	7.96		
S00178	NAS-0091	2.22	0.02	2.24	6.95	0.075	2.74	0.44	101.50			1.19	7.56		
S00179	NAS-0092	1.85	0.02	5.04	4.98	0.090	3.06	0.45	100.67			0.99	6.36		
S00180	NAS-0093	1.82	0.02	1.50	7.37	0.086	1.07	0.32	102.09			1.04	7.78		
S00181	NAS-0094	(1.88)	0.01	1.72	5.87	0.085	1.63	0.39	100.52			0.93	6.34		
S00182	NAS-0095	2.00	0.01	0.88	5.56	0.079	2.15	0.38	100.63			0.95	5.80		
S00183	NAS-0096	1.38	0.02	11.65	5.22	0.11	1.04	0.24	101.11			0.77	8.40		
S00184	NAS-0102	2.02	0.02	1.43	9.55	0.097	1.68	0.77	101.66			1.42	9.94		
S00185	NAS-0103	3.35	0.02	1.69	8.69	0.084	3.81	0.63	102.95			1.54	9.15		
S00186	NAS-0104	1.48	0.02	4.58	5.18	0.11	3.33	0.59	101.56			1.06	6.43		
S00187	NAS-0106	0.75	0.12	0.66	0.42	0.068	4.93	0.88	100.16			0.70	0.60		
S00188	NAS-0107	3.78	0.03	1.39	9.34	0.082	2.51	0.70	101.62			1.48	9.72		
S00189	NAS-0110	1.97	0.02	0.33	6.42	0.085	2.78	1.06	96.68			1.20	6.51		
S00190	NAS-0112	1.52	0.01	2.93	3.63	0.085	4.35	1.32	98.06			1.07	4.43		
S00191	NAS-0114	3.31	0.02	2.09	7.21	0.20	0.62	0.23	101.38			0.96	7.78		
S00192	NAS-0115	2.64	0.02	1.58	5.62	0.081	1.24	0.30	102.21			0.87	6.05		
S00193	NAS-0116	1.52	0.01	3.44	3.16	0.084	2.61	0.35	101.31			0.71	4.10		
S00194	NAS-0117	1.74	0.01	11.95	4.67	0.10	0.69	0.11	99.14			0.65	7.93		
S00195	NAS-0119	2.87	0.02	2.89	5.95	0.10	0.40	0.19	98.89			0.78	6.74		
S00196	NAS-0120	2.05	0.01	2.67	4.67	0.090	1.01	0.42	99.34			0.72	5.40		
S00197	NAS-0121	1.75	0.01	3.11	3.72	0.085	3.20	0.50	100.88			0.86	4.57		
S00198	NAS-0123	1.87	0.01	3.30	3.22	0.13	1.89	0.56	98.09			0.66	4.12		
S00199	NAS-0124	4.50	0.01	2.49	4.38	0.081	1.56	0.53	98.63			0.76	5.06		
S00200	NAS-0125	1.38	0.01	5.50	2.75		2.20	0.48	98.23			0.63	4.25		
S00201	NAS-0126	1.84	0.02	9.03	4.35		0.50	0.38	99.10			0.62	6.81		
S00202	NAS-0129	1.66	0.03	0.66	8.16		0.62	0.55	102.31			1.11	8.34		
S00203	NAS-0130	3.91	0.02	1.50	6.99		1.52	0.55	102.68			1.07	7.40		
S00204	NAS-0131	2.42	0.02	15.36	4.58		1.78	0.28	99.72			0.78	8.77		
S00205	NAS-0134	1.07	0.02	10.08	0.60		4.15	0.84	99.16			0.63	3.35		
S00206	NAS-0135	1.65	0.01	3.44	3.03		3.23	1.21	96.30			0.86	3.97		
S00207	NAS-0138	1.50	0.02	1.12	3.81	0.087	7.21	1.31	99.90			1.41	4.12		
S00208	NAS-0141	1.38	0.02	0.18	6.63	0.11	5.00	1.30	100.40			1.50	6.68		
S00209	NAS-0144	1.97	0.02	2.56	6.70	0.083	4.19	0.78	102.76			1.36	7.40		
S00210	NAS-0145	1.66	0.02	4.39	3.73	0.087	6.28	0.44	102.72			1.20	4.93		
S00211	NAS-0148	3.71	0.02	1.61	7.22	0.092	3.21	0.75	97.58			1.31	7.66		
S00212	NAS-0151	2.50	0.02	0.29	6.51	0.090	4.93	0.87	100.11			1.43	6.59		
S00213	NAS-0153	1.36	0.02	0.37	6.14	0.097	3.57	0.84	96.86			1.23	6.24		

( ) Sulfur value by X-ray fluorescence spectroscopy.

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	SA-CO_2 (m^2/g)	SA-N_2 (m^2/g)
S00214	NAS-0156	3.22	0.02	1.25	8.93	0.080	2.80	0.49	99.29			1.44	9.27		
S00215	NAS-0159	1.34	0.02	0.73	7.65	0.11	2.45	0.43	99.14			1.24	7.85		
S00216	NAS-0161	2.31	0.03	1.21	6.69	0.094	5.32	0.46	102.66			1.45	7.02		
S00217	NAS-0162	(1.77)	0.02	3.56	6.52	0.11	3.97	0.66	100.91			1.30	7.49		
S00218	NAS-0165	2.02	0.01	2.38	5.22	0.091	4.11	0.66	100.31			1.16	5.87		
S00219	NAS-0166	1.49	0.02	0.53	8.32	0.10	2.71	0.61	98.84			1.37	8.46		
S00220	NAS-0167	2.03	0.02	4.25	4.75	0.086	4.04	0.70	102.20			1.10	5.91		
S00221	NAS-0170	2.63	0.02	1.28	6.60	0.098	2.23	0.70	99.07			1.12	6.95		
S00222	NAS-0174	2.40	0.01	0.40	5.94	0.081	5.99	0.96	100.76			1.49	6.05		
S00223	NAS-0176	3.75	0.02	2.02	7.38	0.087	3.66	0.76	96.61			1.38	7.93		
S00224	NAS-0177	1.62	0.02	0.84	5.34	0.097	4.55	0.63	100.01			1.22	5.57		
S00225	NAS-0181	2.11	0.02	1.32	5.94	0.096	2.24	0.59	100.18			1.03	6.30		
S00226	NAS-0183	2.68	0.02	1.03	5.90	0.085	2.77	0.38	101.63			1.06	6.18		
S00227	NAS-0185	1.95	0.02	2.35	4.10	0.10	3.84	0.52	98.50			0.98	4.74		
S00228	NAS-0189	3.05	0.03	1.94	7.46	0.081	3.00	0.53	101.82			1.29	7.99		
S00229	NAS-0192	2.17	0.02	1.72	6.06	0.089	3.65	0.40	98.33			1.18	6.53		
S00230	NAS-0193	1.03	0.02	12.35	3.87	0.089	2.27	0.28	98.29			0.75	7.24		
S00231	NAS-0195	1.92	0.01	1.58	3.65	0.097	5.35	1.19	99.45			1.17	4.08		
S00232	NAS-0196	2.52	0.02	1.34	4.79	0.090	3.95	1.01	99.39			1.13	5.16		
S00233	NAS-0198	2.34	0.01	1.03	5.76	0.089	4.37	0.80	98.59			1.27	6.04		
S00234	NAS-0202	2.54	0.02	0.81	4.36	0.095	4.27	0.44	101.39			1.05	4.58		
S00235	NAS-0206	3.01	0.02	1.10	7.29	0.083	2.09	0.37	101.44			1.15	7.59		
S00236	NAS-0207	2.18	0.02	2.42	6.89	0.081	2.87	0.64	103.70			1.22	7.55		
S00237	NAS-0208	2.11	0.02	2.45	6.25	0.087	3.66	0.63	99.97			1.23	6.92		
S00238	NAS-0212	2.69	0.03	1.28	8.79	0.090	4.70	0.62	102.48			1.65	9.14		
S00239	NAS-0213	1.47	0.02	1.17	8.03	0.096	2.71	0.30	100.75			1.30	8.35		
S00240	NAS-0214	2.05	0.02	0.92	6.91	0.092	3.48	0.37	99.57			1.26	7.16		
S00241	NAS-0215	3.70	0.02	14.00	3.94	0.083	2.83	0.18	100.37			0.81	7.76		
S00242	NAS-0216	1.40	0.01	0.99	4.94	0.098	6.90	0.58	100.44			1.43	5.21		
S00243	NAS-0219	2.36	0.02	0.68	5.15	0.085	6.52	0.96	99.26			1.39	5.34		
S00244	NAS-0222	0.21	0.01	1.50	0.59	0.073	6.67	0.38	102.83			0.86	1.00		
S00245	NAS-0224	1.27	0.01	1.10	4.11	0.086	4.97	0.63	99.07			1.12	4.41		
S00246	NAS-0227	1.80	0.02	0.22	5.45	0.095	5.41	0.90	100.73			1.36	5.51		
S00247	NAS-0229	1.72	0.01	0.73	5.19	0.097	5.23	1.00	98.02			1.32	5.39		
S00248	NAS-0233	1.56	0.02	0.40	3.91	0.089	3.79	0.78	97.95			0.98	4.02		
S00249	NAS-0234	1.82	0.02	2.42	5.25	0.080	4.52	0.57	99.18			1.20	5.91		
S00250	NAS-0237	1.27	0.01	2.02	2.08	0.096	4.99	0.64	98.47			0.88	2.63		
S00251	NAS-0240	3.25	0.01	1.94	5.27	0.088	5.85	0.92	100.50			1.39	5.80		
S00252	NAS-0242	2.02	0.02	1.87	5.04	0.090	3.69	1.00	98.75			1.13	5.55		
S00253	NAS-0246	2.87	0.02	2.16	7.86	0.068	1.48	0.55	98.74			1.17	8.45		
S00254	NAS-0247	3.04	0.02	1.61	5.88	0.066	3.20	0.50	101.06			1.12	6.32		
S00255	NAS-0249	2.25	0.02	10.11	4.79	0.076	2.34	0.39	97.01			0.88	7.55		
S00256	NAS-0252	2.76	0.02	1.10	4.87	0.084	1.95	0.42	100.30			0.85	5.17		
S00257	NAS-0253	1.87	0.02	2.64	4.32	0.098	4.25	0.50	101.89			1.05	5.04		
S00269	NAS-0292	2.37	0.02	1.48	7.54	0.096	2.16	0.93	100.72			1.25	7.94		
S00270	NAS-0295	2.58	0.02	0.58	5.52	0.10	2.45	0.56	96.86			1.00	5.68		
S00271	NAS-0298	2.54	0.02	0.64	6.12	0.091	4.00	0.97	98.97			1.29	6.29		
S00272	NAS-0300	2.50	0.02	1.50	6.47	0.076	3.18	0.87	99.83			1.23	6.88		
S00273	NAS-0307	3.48	0.02	2.96	5.81	0.090	2.81	0.43	98.47			1.06	6.62		

( ) Sulfur value by X-ray fluorescence spectroscopy.

Table C1. Continued.

Sample no.	Geol. no.	S (%)	Cl (%)	CO_2 (%)	Org. C (%)	F (%)	H_2O+ (%)	H_2O- (%)	Total (%)	Pyr. S (%)	Sulf. S (%)	Total H (%)	Total C (%)	SA-CO_2 (m^2/g)	SA-N_2 (m^2/g)
S00274	NAS-0309	2.64	0.02	1.31	6.74	0.089	2.03	0.39	96.70			1.08	7.10		
S00275	NAS-0314	2.41	0.01	1.11	6.52	0.087	2.18	0.84	97.39			1.12	6.82		
S00276	NAS-0317	1.89	0.02	0.90	5.66	0.081	5.11	0.97	98.58			1.36	5.91		
S00277	NAS-0320	2.74	0.02	0.93	7.33	0.088	2.44	0.60	96.61			1.22	7.58		
S00278	NAS-0322	2.66	0.02	2.13	5.48	0.071	2.91	0.60	96.90			1.05	6.06		
S00279	NAS-0325	1.75	0.02	1.09	7.16	0.088	2.78	0.71	100.69			1.25	7.46		
S00280	NAS-0331	2.24	0.03	2.41	6.38	0.094	2.84	0.68	100.09			1.16	7.04		
S00281	NAS-0335	2.83	0.02	1.42	6.62	0.083	1.84	0.44	100.46			1.05	7.01		
S00282	NAS-0338	2.49	0.02	1.69	5.84	0.090	2.00	0.41	98.97			0.97	6.30		
S00283	NAS-0343	2.21	0.02	1.34	6.05	0.084	0.78	0.42	97.92			0.86	6.42		
S00284	NAS-0346	1.47	0.02	3.55	6.09	0.095	1.91	0.50	102.05			1.00	7.06		
S00285	NAS-0348	2.65	0.02	3.32	8.48	0.094	1.34	0.47	96.75			1.22	9.39		
S00286	NAS-0351	2.88	0.02	2.15	7.58	0.12	1.30	0.40	98.82			1.10	8.17		
S00287	NAS-0355	2.67	0.02	1.99	5.76	0.079	1.56	0.31	97.94			0.90	6.30		
S00288	NAS-0359	3.44	0.02	1.09	7.64	0.082	0.33	0.32	100.94			0.99	7.94		
S00289	NAS-0360	2.23	0.01	1.91	5.26	0.094	3.05	0.34	98.07			1.01	5.78		
S00290	NAS-0361	1.09	0.02	0.62	4.74	0.087	5.59	0.41	97.09			1.24	4.91		
S00291	NAS-0366	1.59	0.02	1.12	5.61	0.085	3.52	0.47	98.43			1.12	5.92		
S00292	NAS-0369	2.34	0.02	2.32	7.45	0.095	3.63	0.45	98.14			1.35	8.08		
S00293	NAS-0370	2.71	0.02	1.60	8.26		1.49	0.55	96.12			1.22	8.70		
S00294	NAS-0377	1.49	0.01	1.04	5.57	0.093	2.27	0.69	98.53			1.00	5.85		
S00295	NAS-0380	1.94	0.02	0.74	9.15	0.094	1.70	0.73	97.51			1.37	9.35		
S00296	NAS-0383	1.59	0.02	0.27	5.27	0.085	2.87	0.59	98.27			1.02	5.34		
S00297	NAS-0389	1.76	0.01	1.25	6.01	0.080	3.08	0.66	100.86			1.14	6.35		
S00298	NAS-0393	2.59	0.02	1.56	5.77	0.077	1.20	0.30	98.58			0.86	6.20		
S00299	NAS-0396	1.82	0.02	2.93	3.84	0.086	2.27	0.31	98.71			0.75	4.64		
S00300	NAS-0398	3.15	0.02	1.43	7.28			1.08	100.60			0.84	7.67		
S00301	NAS-0402	0.10	0.02	4.31	1.94	0.077	2.88	0.31	99.32			0.59	3.12		
S00302	NAS-0409	3.87	0.01	1.81	6.73	0.098	2.56	0.59	98.79			1.16	7.22		
S00303	NAS-0413	1.24	0.02	0.77	4.01	0.097	3.98	0.30	99.05			0.96	4.22		
S00304	NAS-0415	2.17	0.02	1.59	6.62	0.097	1.79	0.76	98.33			1.08	7.05		
S00305	NAS-0417	1.99	0.02	1.40	4.72	0.098	1.66	0.34	97.46			0.79	5.10		
S00306	NAS-0421	2.86	0.02	2.77	6.92	0.073	0.60	0.29	99.54			0.93	7.68		
S00307	NAS-0424	1.78	0.02	2.51	4.49	0.095	1.96	0.28	98.46			0.79	5.18		
S00308	NAS-0427	1.62	0.02	1.15	7.48	0.077	0.78	0.31	99.27			1.02	7.80		
S00309	NAS-0431	1.98	0.02	3.79	5.60	0.078	1.73	0.31	99.99			0.90	6.63		
S00310	NAS-0434	3.03	0.02	2.50	6.96	0.078	0.33	0.25	99.94			0.90	7.64		
S00311	NAS-0438	1.26	0.02	15.18	2.96	0.089	1.22	0.25	99.86			0.52	7.10		
S00312	NAS-0444	1.68	0.02	0.67	4.84	0.14	3.73	1.00	100.96			1.11	5.02		
S00313	NAS-0447	1.82	0.02	2.63	5.53	0.089	1.83	0.46	100.54			0.92	6.25		
S00314	NAS-0451	1.61	0.02	5.45	3.77	0.10	2.75	0.45	99.70			0.81	5.26		
S00315	NAS-0454	1.39	0.02	1.10	4.16	0.093	5.14	0.68	101.68			1.15	4.46		
S00316	NAS-0459	5.81	0.03	0.31	8.82	0.099	1.42	0.83	97.07			1.31	8.90		
S00317	NAS-0460	1.41	0.02	0.73	5.29	0.084	4.89	0.61	101.58			1.25	5.49		
S00318	NAS-0464	1.93	0.02	0.59	4.65	0.086	3.99	0.50	100.92			1.06	4.81		
S00319	NAS-0466	1.14	0.01	0.36	4.46	0.082	3.33	0.56	99.11			0.97	4.56		
S00320	NAS-0470	2.08	0.02	1.04	2.70	0.064	3.95	0.48	99.77			0.82	2.98		
S00321	NAS-0473	2.92	0.02	2.38	5.53	0.088	1.80	0.31	101.36			0.90	6.18		
S00322	NAS-0476	1.53	0.02	18.99	3.33	0.084	1.43	0.18	100.63			0.58	8.51		

no.	no.	(ppm)	(ppm)	(ppm)	(ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00001	01KY01C1	3.6	120.	13.	160.	70.	110.	41.	110.	94.	80.	17.	1.4	68.
S00002	01KY02C1	4.7	140.	12.	140.	59.	310.	30.	76.	71.	56.	15.	2.0	38.
S00003	01KY03C1	4.3	180.	13.	170.	62.	260.	24.	85.	85.	220.	13.	1.7	42.
S00004	01KY04C1	4.2	240.	17.	150.	83.	270.	12.	33.	69.	89.	22.	1.5	17.
S00005	01KY05C1	3.2	180.	14.	120.	62.	410.	33.	84.	75.	160.	11.	<0.4	37.
S00006	01KY06C1	3.5	290.	23.	150.	100.	360.	12.	24.	36.	66.	23.	<0.4	9.8
S00007	01KY07C1	4.0	210.	16.	>560.	94.	160.	26.	290.	160.	410.	22.	1.0	45.
S00008	01KY08C1	3.8	240.	20.	190.	110.	190.	14.	80.	150.	180.	19.	<0.4	15.
S00033	01KY08L1	4.7	190.	20.	260.	120.	200.	13.	120.	150.	180.	22.	0.7	23.
S00009	01KY09C1	3.8	230.	17.	170.	92.	360.	12.	80.	130.	83.	16.	<0.4	12.
S00034	01KY10L1	3.2	230.	15.	120.	73.	360.	7.8	68.	82.	51.	18.	<0.4	5.7
S00010	01KY10C1	3.8	190.	18.	190.	93.	200.	12.	120.	190.	140.	16.	1.1	10.
S00035	01KY11L1	4.2	320.	16.	120.	75.	330.	8.4	96.	150.	270.	16.	2.4	11.
S00011	01KY11C1	3.1	170.	15.	150.	63.	400.	13.	100.	130.	160.	14.	<0.4	16.
S00012	01KY12C1	2.7	150.	10.	230.	56.	320.	12.	120.	130.	90.	13.	<0.4	17.
S00036	01KY12L1	3.6	150.	12.	220.	60.	370.	12.	120.	120.	170.	12.	<0.4	11.
S00037	01KY13L1	3.4	120.	12.	250.	64.	360.	12.	150.	110.	170.	8.7	<0.4	17.
S00013	01KY13C1	2.9	130.	13.	480.	78.	360.	13.	230.	210.	360.	12.	0.6	19.
S00393	02KY01C1	3.0	130.	13.	110.	56.	160.	37.	95.	52.	42.	16.	1.3	81.
S00394	02KY02C1	5.0	120.	14.	230.	62.	270.	44.	93.	83.	50.	16.	1.5	69.
S00395	02KY03C1	3.6	160.	17.	180.	66.	260.	32.	88.	67.	1600.	18.	2.9	55.
S00396	02KY04C1	5.4	190.	19.	230.	80.	460.	28.	81.	95.	82.	20.	2.0	30.
S00397	02KY05C1	4.9	180.	19.	250.	76.	400.	27.	88.	80.	170.	22.	1.6	30.
S00398	02KY06C1	3.6	130.	16.	210.	63.	510.	21.	80.	76.	40.	17.	1.2	54.
S00399	02KY07C1	4.8	180.	20.	240.	80.	310.	32.	110.	100.	150.	21.	1.5	26.
S00400	02KY08C1	3.8	160.	18.	210.	86.	700.	14.	120.	160.	31.	18.	2.0	13.
S00401	02KY09C1	2.6	150.	13.	300.	68.	1100.	11.	130.	230.	<11.	12.	1.8	10.
S00014	01IL01L2	3.5	160.	15.	220.	100.	220.	9.8	39.	13.	59.	16.	2.5	2.6
S00015	01IL03L1	2.3	100.	10.	78.	87.	290.	6.0	24.	26.	45.	12.	4.6	2.9
S00016	01IL04L1	2.4	100.	11.	70.	86.	120.	5.3	27.	14.	130.	14.	4.0	4.3
S00017	01IL05L1	2.9	110.	15.	120.	97.	150.	7.6	27.	12.	49.	16.	4.3	3.9
S00018	01IL07L1	1.4	72.	10.	83.	53.	960.	7.1	21.	11.	35.	8.2	<0.4	2.3
S00019	01IL09L1	3.4	130.	19.	110.	89.	340.	12.	39.	19.	31.	20.	1.8	5.9
S00020	01IL09L2	3.1	120.	19.	86.	95.	240.	15.	42.	22.	120.	25.	2.7	6.0
S00021	01IL10L1	3.2	160.	18.	76.	94.	210.	14.	38.	32.	1000.	18.	2.4	9.8
S00022	01IL11L1	4.6	170.	24.	170.	100.	260.	17.	70.	53.	100.	24.	2.8	7.7
S00023	01IL12L1	4.4	140.	23.	140.	100.	280.	13.	59.	36.	100.	26.	2.3	8.2
S00024	01IL13L1	4.4	140.	25.	160.	110.	280.	16.	65.	39.	120.	25.	0.6	10.
S00025	01IL14L1	3.8	150.	21.	160.	100.	230.	16.	61.	46.	150.	22.	1.5	19.
S00026	01IL15L1	4.1	140.	22.	200.	100.	240.	26.	78.	67.	260.	21.	1.2	25.
S00027	01IL16L1	4.1	120.	21.	240.	84.	260.	45.	79.	130.	100.	14.	1.2	22.
S00028	01IL17L1	4.1	130.	18.	120.	76.	230.	24.	50.	62.	54.	16.	1.2	14.
S00029	01IL18L1	3.6	130.	15.	140.	64.	190.	20.	45.	55.	85.	16.	1.2	14.
S00030	01IL19L1	4.1	130.	16.	140.	69.	270.	27.	59.	68.	44.	11.	1.5	11.
S00031	01IL20L1	3.5	140.	15.	120.	73.	340.	19.	61.	56.	34.	19.	0.8	36.
S00032	01IL21L1	4.3	200.	18.	290.	92.	340.	14.	110.	71.	100.	23.	0.9	16.
S00038	02IL01L2	<0.87	24.	4.1	82.	28.	910.	4.3	13.	9.1	5.	4.	<1.	0.5
S00051	02IL01C1	3.7	160.	15.	200.	85.	190.	21.	75.	42.	400.	22.	2.3	27.
S00052	02IL02C1	3.5	160.	16.	150.	89.	200.	12.	41.	37.	350.	20.	2.4	9.7

Table C1. Continued.

Sample no.	Geol. no.	Be (ppm)	B (ppm)	Sc (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00053	02IL03C1	3.8	120.	13.	160.	64.	310.	26.	69.	78.	140.	17.	2.5	41.
S00054	02IL04C1	4.1	120.	14.	170.	64.	230.	31.	78.	84.	140.	17.	2.3	64.
S00055	02IL04C2	4.0	120.	15.	180.	72.	420.	27.	74.	76.	30.	19.	1.8	40.
S00056	02IL05C1	4.0	150.	16.	240.	73.	260.	26.	88.	99.	190.	24.	1.8	37.
S00039	02IL05L2	4.0	160.	19.	150.	92.	360.	18.	64.	56.	290.	24.	6.4	21.
S00057	02IL06C1	4.3	160.	19.	220.	80.	240.	25.	99.	91.	160.	23.	1.7	32.
S00040	02IL06L2	3.6	150.	20.	140.	91.	290.	15.	48.	51.	61.	24.	6.7	17.
S00058	02IL07C1	3.8	180.	19.	150.	89.	310.	22.	54.	67.	140.	18.	2.0	21.
S00059	02IL08C1	4.5	250.	20.	160.	85.	300.	22.	69.	97.	120.	26.	2.2	21.
S00041	02IL09L1	<0.87	6.6	0.6	24.	7.1	1700.	11.	12.	2.	4.	0.5	5.0	2.6
S00042	03IL01L1	1.9	190.	12.	160.	59.	1100.	15.	62.	34.	25.	15.	3.7	12.
S00043	03IL07L1	4.0	140.	13.	160.	59.	310.	27.	82.	80.	89.	17.	<6.6	46.
S00044	03IL12L1	4.2	180.	18.	200.	84.	250.	25.	95.	100.	130.	21.	<6.7	28.
S00045	03IL20L1	3.9	280.	22.	230.	110.	200.	15.	60.	100.	90.	23.	<7.2	11.
S00046	03IL20L3	3.3	250.	20.	220.	110.	460.	14.	72.	87.	76.	22.	6.5	9.6
S00047	03IL23L1	3.4	180.	15.	140.	72.	210.	20.	68.	110.	63.	19.	6.7	22.
S00048	03IL26L1	3.7	220.	20.	490.	93.	270.	19.	180.	180.	340.	17.	1.8	21.
S00096	04IL01C1	4.4	140.	19.	80.	84.	360.	19.	33.	19.	39.	23.	2.2	15.
S00097	04IL02C1	4.2	120.	18.	82.	84.	440.	18.	33.	21.	44.	21.	2.5	14.
S00098	04IL03C1	3.7	120.	18.	77.	79.	540.	17.	28.	13.	39.	19.	2.4	20.
S00099	04IL04C1	4.1	130.	20.	88.	90.	600.	19.	33.	14.	44.	20.	2.0	25.
S00100	04IL05C1	3.8	130.	17.	75.	78.	890.	19.	32.	20.	66.	19.	2.5	25.
S00101	04IL06C1	3.9	130.	21.	86.	95.	470.	20.	33.	15.	49.	19.	1.9	29.
S00102	04IL07C1	3.5	130.	20.	66.	84.	430.	19.	27.	20.	41.	23.	2.1	24.
S00103	04IL08C1	3.9	140.	18.	74.	79.	430.	17.	30.	18.	51.	23.	1.9	21.
S00104	04IL09C1	3.9	120.	21.	86.	93.	400.	16.	33.	25.	50.	24.	2.6	7.9
S00105	04IL10C1	4.0	140.	23.	83.	100.	350.	17.	37.	17.	58.	24.	2.8	6.7
S00106	04IL11C1	3.4	120.	20.	86.	83.	450.	20.	34.	22.	58.	21.	2.4	7.6
S00107	04IL12C1	3.6	110.	21.	94.	87.	450.	18.	29.	19.	48.	23.	1.7	5.1
S00108	04IL13C1	3.7	120.	18.	140.	84.	390.	19.	44.	23.	94.	24.	2.8	8.6
S00109	04IL14C1	4.0	120.	21.	130.	83.	380.	22.	43.	37.	50.	21.	1.4	13.
S00110	04IL15C1	3.7	120.	21.	140.	85.	330.	20.	41.	38.	340.	26.	3.1	9.6
S00111	04IL16C1	3.7	120.	22.	150.	85.	330.	21.	45.	44.	76.	24.	1.3	11.
S00159	04IL17L1	2.6	150.	19.	130.	86.	300.	18.	53.	38.	40.	19.	2.7	15.
S00112	04IL17C1	4.3	110.	19.	120.	77.	290.	22.	44.	53.	63.	20.	2.2	17.
S00113	04IL18C1	3.3	110.	21.	130.	81.	300.	17.	32.	22.	170.	23.	3.3	15.
S00114	04IL19C1	3.2	110.	19.	110.	79.	300.	14.	29.	25.	100.	22.	3.6	4.5
S00160	04IL19L1	3.1	130.	20.	130.	95.	300.	20.	56.	50.	68.	22.	3.8	14.
S00115	04IL20C1	3.7	120.	24.	160.	86.	320.	25.	60.	77.	110.	25.	2.8	24.
S00116	04IL21C1	4.0	110.	21.	140.	78.	370.	16.	35.	37.	76.	30.	1.6	9.8
S00117	04IL22C1	4.2	140.	22.	140.	87.	370.	21.	42.	38.	77.	26.	1.8	10.
S00118	04IL23C1	4.3	120.	21.	140.	84.	370.	19.	40.	44.	89.	26.	1.6	13.
S00119	04IL24C1	4.0	130.	21.	140.	82.	390.	17.	36.	41.	100.	24.	1.9	8.1
S00120	04IL25C1	4.1	120.	20.	130.	78.	420.	17.	34.	36.	130.	23.	1.5	7.0
S00121	04IL26C1	3.9	120.	21.	130.	84.	340.	22.	39.	46.	110.	26.	2.6	15.
S00161	04IL27L1	2.3	110.	15.	120.	70.	570.	14.	36.	21.	32.	17.	1.3	17.
S00122	04IL27C1	<2.5	63.	11.	77.	41.	870.	11.	20.	8.5	36.	12.	<0.6	11.
S00123	04IL28C1	<3.2	61.	14.	86.	56.	660.	12.	19.	7.8	16.	16.	<0.5	4.8
S00162	04IL29L1	<0.88	43.	5.7	40.	30.	660.	10.	14.	3.8	12.	6.7	1.1	29.

Sample no.	Geol. no.	Be (ppm)	B (ppm)	Sc (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00124	04IL29C1	<0.85	27.	2.5	21.	10.	780.	5.	6.1	4.5	<4.	3.2	<0.5	17.
S00125	04IL30C1	<0.87	19.	3.4	33.	11.	670.	4.	4.3	3.3	6.	4.1	<0.5	2.4
S00172	05IL01L1	3.1	130.	20.	140.	83.	280.	26.	68.	79.	45.	21.	3.0	18.
S00173	05IL01L2	3.4	130.	17.	200.	79.	230.	20.	100.	67.	260.	22.	2.7	30.
S00174	05IL01L3	3.0	130.	19.	240.	89.	260.	23.	130.	69.	120.	19.	2.9	34.
S00073	06IL04C1	3.4	130.	16.	85.	71.	370.	13.	25.	11.	52.	21.	2.0	25.
S00074	06IL05C1	3.8	140.	19.	120.	84.	410.	16.	37.	14.	55.	24.	2.2	14.
S00075	06IL06C1	3.4	120.	18.	95.	77.	420.	15.	27.	12.	51.	19.	1.8	23.
S00076	06IL07C1	3.2	120.	14.	86.	64.	470.	18.	27.	12.	260.	17.	2.2	31.
S00077	06IL08C1	4.2	160.	18.	120.	81.	400.	17.	39.	21.	62.	22.	2.6	20.
S00078	06IL09C1	4.2	140.	20.	110.	91.	540.	18.	29.	19.	58.	23.	2.4	9.4
S00079	06IL10C1	4.0	140.	19.	100.	85.	430.	15.	36.	17.	65.	21.	2.3	9.2
S00080	06IL11C1	4.3	160.	20.	100.	87.	350.	15.	38.	19.	85.	25.	3.1	10.
S00163	06IL11L1	3.2	110.	16.	100.	81.	610.	16.	40.	18.	51.	17.	2.3	11.
S00081	06IL12C1	4.0	150.	19.	96.	86.	330.	13.	34.	15.	57.	26.	2.8	8.3
S00082	06IL13C1	3.6	140.	18.	92.	75.	400.	15.	29.	17.	52.	23.	2.1	9.0
S00164	06IL13L1	3.2	150.	20.	110.	97.	370.	19.	46.	26.	55.	24.	2.8	7.1
S00165	06IL13L2	3.4	170.	21.	120.	100.	280.	21.	53.	27.	84.	26.	3.3	14.
S00166	06IL14L1	3.0	130.	18.	80.	83.	750.	16.	41.	23.	38.	20.	1.8	11.
S00083	06IL14C1	3.6	180.	18.	93.	79.	380.	14.	29.	22.	62.	24.	2.3	10.
S00084	06IL15C1	3.8	140.	18.	100.	79.	360.	16.	35.	18.	74.	25.	2.2	15.
S00085	06IL16C1	4.2	220.	17.	92.	79.	430.	15.	40.	24.	50.	22.	1.6	10.
S00086	06IL17C1	3.9	180.	17.	110.	80.	470.	15.	43.	38.	180.	23.	1.5	19.
S00087	06IL18C1	4.2	170.	18.	140.	83.	300.	16.	46.	42.	94.	25.	1.6	11.
S00088	06IL19C1	4.9	170.	26.	160.	85.	280.	21.	72.	64.	140.	22.	1.7	25.
S00167	06IL19L1	4.5	94.	18.	150.	82.	210.	36.	90.	73.	220.	22.	2.9	43.
S00089	06IL20C1	4.6	150.	19.	240.	71.	240.	41.	91.	110.	310.	18.	2.2	50.
S00168	06IL21L1	3.0	100.	15.	140.	70.	230.	59.	73.	76.	49.	17.	3.3	60.
S00090	06IL21C1	4.6	160.	26.	140.	79.	240.	28.	64.	54.	120.	23.	1.7	28.
S00169	06IL22L1	3.7	120.	20.	140.	87.	270.	20.	62.	49.	190.	21.	3.3	20.
S00091	06IL22C1	3.9	160.	29.	140.	86.	270.	19.	65.	49.	240.	24.	1.8	17.
S00092	06IL23C1	4.2	190.	26.	130.	84.	340.	22.	52.	60.	80.	28.	1.9	15.
S00093	06IL24C1	3.1	160.	20.	88.	69.	350.	13.	38.	21.	74.	17.	1.9	19.
S00170	06IL25L1	2.8	140.	19.	130.	87.	250.	17.	50.	39.	130.	18.	3.4	18.
S00094	06IL25C1	3.6	220.	27.	150.	92.	240.	15.	62.	46.	200.	22.	1.9	15.
S00171	06IL25L2	1.0	57.	8.7	89.	44.	970.	17.	43.	29.	6.	9.0	<1.0	18.
S00126	07IL01L1	<0.86	9.8	2.3	46.	12.	550.	2.	9.8	<1.4	13.	2.4	<5.0	0.5
S00127	07IL01L2	4.1	200.	20.	1600.	180.	190.	30.	260.	60.	1100.	25.	2.0	6.8
S00128	07IL01L3	2.5	140.	15.	140.	81.	580.	15.	39.	17.	74.	18.	2.0	6.0
S00129	07IL02L1	3.1	150.	15.	190.	96.	170.	10.	31.	14.	43.	18.	5.7	9.7
S00130	07IL02L2	<2.0	52.	7.9	90.	34.	520.	8.6	38.	17.	<5.	7.7	<5.0	38.
S00131	07IL03L1	3.1	130.	15.	190.	88.	150.	8.5	45.	49.	300.	20.	5.0	5.4
S00132	07IL04L1	3.4	140.	17.	210.	79.	220.	26.	110.	94.	110.	20.	3.4	33.
S00133	07IL04L2	3.4	160.	17.	200.	84.	230.	22.	92.	88.	340.	21.	3.9	24.
S00134	07IL05L1	<0.86	80.	0.9	19.	8.7	800.	8.8	13.	3.9	5.	0.8	8.6	20.
S00135	09IL01L3	3.1	110.	18.	130.	85.	210.	23.	67.	78.	170.	20.	4.7	30.
S00323	10IL01L1	6.1	230.	21.	240.	89.	240.	25.	68.	100.	110.	26.	2.3	26.
S00324	10IL01L2	4.4	180.	18.	300.	79.	230.	23.	81.	67.	150.	21.	1.8	20.
S00325	10IL01L3	1.4	98.	6.6	160.	33.	180.	6.7	21.	33.	40.	6.2	0.8	11.

Table C1. Continued.

Sample no.	Geol. no.	Be (ppm)	B (ppm)	Sc (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00326	10IL01L4	0.26	28.	7.5	190.	31.	620.	11.	43.	75.	<7.	7.5	0.3	15.
S00327	10IL01L5	0.27	31.	2.9	140.	16.	590.	14.	14.	34.	<7.	3.	0.2	6.
S00328	10IL01L6	0.42	51.	9.8	200.	42.	930.	37.	69.	44.	<10.	9.7	0.2	17.
S00329	10IL01L7	0.17	20.	0.9	64.	16.	430.	29.	15.	16.	23.	1.	4.6	2.
S00330	11IL02C1	21.	190.	21.	210.	93.	44.	38.	140.	130.	310.	22.	2.8	70.
S00331	11IL03C1	5.5	30.	19.	170.	74.	400.	36.	100.	110.	120.	23.	2.7	71.
S00377	11IL04L1	110.	16.	17.	220.	92.	310.	30.	88.	82.	840.	19.	1.9	77.
S00378	11IL04L*	95.	28.	36.	320.	330.	1800.	53.	200.	80.	510.	13.	1.1	190.
S00332	11IL04C1	4.5	16.	20.	99.	91.	300.	25.	130.	100.	54.	19.	2.3	57.
S00333	11IL05C1	15.	130.	19.	99.	84.	360.	16.	26.	42.	98.	27.	1.6	36.
S00334	11IL06C1	7.1	37.	18.	170.	80.	370.	19.	57.	67.	78.	21.	2.8	36.
S00335	11IL07C2	65.	190.	23.	240.	100.	480.	20.	47.	51.	120.	26.	2.1	40.
S00336	11IL08C1	29.	160.	19.	180.	84.	640.	18.	58.	46.	110.	23.	2.5	35.
S00337	11IL09C1	7.5	10.	28.	190.	110.	460.	56.	56.	61.	89.	24.	1.7	48.
S00338	11IL10C1	8.0	4.9	17.	140.	100.	270.	59.	50.	63.	110.	<12.	1.4	46.
S00379	11IL10L1	8.7	13.	17.	120.	70.	660.	17.	22.	36.	29.	12.	1.7	29.
S00339	11IL11C1	7.5	23.	17.	170.	87.	300.	17.	74.	67.	190.	20.	2.2	45.
S00380	11IL11L1	120.	14.	18.	170.	100.	380.	53.	76.	69.	160.	15.	1.5	44.
S00340	11IL12C1	8.9	3.9	19.	190.	90.	240.	31.	100.	100.	110.	19.	2.3	74.
S00381	11IL12L1	5.2	8.2	33.	180.	110.	370.	25.	67.	68.	170.	24.	2.7	39.
S00341	11IL13C1	4.9	15.	20.	250.	95.	210.	30.	160.	72.	120.	21.	2.1	83.
S00342	11IL14C1	4.0	19.	18.	240.	93.	240.	17.	130.	98.	120.	21.	1.9	64.
S00343	11IL15C1	6.0	28.	17.	330.	97.	170.	22.	180.	110.	160.	17.	2.8	77.
S00344	11IL16C1	41.	8.0	9.6	120.	84.	200.	30.	110.	91.	56.	12.	1.9	72.
S00345	11IL17C1	13.	57.	20.	200.	100.	240.	23.	95.	91.	130.	21.	2.6	47.
S00346	11IL17C2	2.8	8.0	13.	160.	79.	200.	21.	88.	70.	37.	18.	1.7	110.
S00347	11IL18C1	14.	58.	21.	150.	110.	230.	20.	74.	80.	120.	19.	2.8	35.
S00348	11IL19C1	6.1	6.8	13.	130.	74.	190.	22.	78.	80.	180.	15.	1.6	39.
S00349	11IL20C1	43.	33.	23.	200.	56.	200.	17.	75.	110.	180.	20.	2.6	64.
S00350	11IL21C1	5.2	11.	18.	160.	75.	330.	14.	73.	75.	150.	22.	3.3	26.
S00402	12IL01C1	5.7	190.	18.	450.	140.	160.	14.	140.	110.	290.	22.	2.8	92.
S00403	12IL01C2	4.7	190.	19.	280.	120.	170.	14.	110.	110.	280.	22.	2.5	25.
S00404	12IL01C3	4.3	180.	16.	430.	120.	290.	12.	120.	97.	380.	18.	2.6	21.
S00405	12IL01C4	4.4	170.	17.	270.	110.	180.	12.	100.	80.	150.	19.	2.2	31.
S00407	13IL04C1	2.6	200.	17.	250.	74.	1700.	16.	45.	86.	26.	19.	1.8	15.
S00408	13IL05C1	5.7	250.	19.	260.	140.	180.	16.	110.	73.	240.	20.	3.0	42.
S00409	13IL06C2	4.2	230.	17.	310.	100.	130.	12.	70.	99.	180.	21.	3.0	32.
S00410	13IL07C2	2.9	150.	13.	440.	87.	580.	11.	94.	86.	560.	16.	1.8	18.
S00411	13IL08C1	3.4	200.	14.	470.	91.	120.	13.	120.	85.	270.	14.	2.1	30.
S00412	13IL09C1	4.5	170.	16.	270.	80.	540.	41.	110.	68.	74.	19.	1.9	58.
S00413	13IL10C1	4.5	140.	16.	210.	76.	460.	31.	100.	51.	120.	20.	1.7	47.
S00414	13IL11C2	3.0	170.	16.	160.	70.	180.	31.	110.	100.	32.	19.	2.6	60.
S00415	13IL12C3	4.0	170.	18.	150.	78.	190.	26.	90.	80.	46.	21.	2.1	54.
S00416	13IL13C2	3.1	150.	14.	130.	63.	210.	26.	74.	99.	140.	18.	1.4	50.
S00417	13IL14C3	5.3	230.	19.	170.	79.	260.	29.	110.	140.	150.	23.	2.8	41.
S00418	13IL15C2	4.8	230.	20.	170.	85.	250.	31.	83.	96.	300.	24.	2.6	37.
S00419	13IL16C2	5.0	240.	21.	210.	85.	250.	29.	110.	120.	170.	25.	3.1	31.
S00420	13IL17C4	3.4	190.	18.	220.	81.	530.	19.	66.	87.	380.	20.	3.0	18.
S00421	13IL18C2	3.7	240.	20.	170.	92.	240.	29.	110.	99.	80.	22.	2.3	29.

* Sample 11IL04L* is a dike in 11IL04L1.

Sample no.	Geol. no.	Be (ppm)	B (ppm)	Sc (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00422	13IL19C1	3.7	200.	18.	270.	83.	390.	20.	100.	74.	140.	21.	3.3	19.
S00423	13IL20C1	4.1	210.	19.	260.	91.	310.	17.	87.	81.	170.	22.	3.0	15.
S00424	13IL21C2	3.8	190.	19.	270.	100.	320.	16.	110.	120.	120.	23.	2.6	22.
S00425	13IL22C2	3.5	210.	21.	180.	110.	250.	15.	66.	87.	380.	23.	3.2	13.
S00426	13IL23C4	3.2	180.	20.	210.	88.	180.	23.	65.	90.	83.	21.	2.8	13.
S00427	13IL24C2	2.0	100.	15.	230.	65.	440.	13.	54.	76.	73.	14.	1.7	19.
S00428	13IL25C3	0.93	46.	9.8	350.	50.	390.	8.5	85.	140.	140.	10.	1.5	11.
S00429	13IL26C3	1.3	53.	10.	300.	59.	360.	12.	91.	120.	160.	12.	1.8	7.8
S00430	13IL27C1	1.4	84.	12.	320.	59.	380.	16.	100.	110.	140.	13.	1.5	11.
S00352	01IN01C1	4.6	190.	19.	520.	150.	160.	26.	290.	130.	3600.	19.	5.1	13.
S00353	01IN01C2	4.0	180.	15.	430.	110.	150.	11.	120.	99.	510.	18.	2.8	41.
S00354	01IN02C1	4.1	170.	15.	250.	81.	270.	21.	78.	75.	320.	17.	2.9	35.
S00355	01IN03C1	4.0	160.	15.	210.	72.	360.	25.	75.	69.	130.	16.	2.0	28.
S00356	01IN03C2	5.2	170.	16.	430.	81.	310.	30.	100.	67.	200.	19.	2.3	27.
S00357	01IN03C3	4.8	150.	16.	210.	83.	300.	34.	95.	72.	56.	17.	1.7	46.
S00358	01IN04C1	5.2	150.	14.	190.	66.	200.	38.	91.	79.	51.	19.	1.6	56.
S00359	01IN04C2	3.7	140.	14.	270.	67.	320.	32.	90.	88.	35.	20.	1.8	66.
S00360	01IN05C1	5.2	200.	18.	150.	86.	210.	27.	87.	95.	370.	20.	4.0	49.
S00361	01IN05C2	5.4	200.	19.	160.	87.	270.	24.	96.	91.	170.	24.	3.4	38.
S00362	01IN05C3	4.3	200.	20.	150.	86.	310.	24.	72.	92.	240.	21.	3.4	31.
S00363	01IN07C1	4.0	220.	21.	200.	96.	320.	21.	87.	91.	170.	26.	2.4	27.
S00364	01IN07C2	3.9	200.	23.	170.	110.	330.	23.	61.	57.	120.	25.	3.3	19.
S00365	01IN08C1	4.8	250.	21.	340.	90.	280.	25.	90.	200.	160.	27.	3.4	19.
S00366	01IN08C2	4.9	230.	19.	190.	82.	240.	24.	61.	190.	97.	21.	3.1	24.
S00367	01IN09C1	5.0	210.	19.	180.	83.	210.	27.	140.	170.	98.	21.	2.3	27.
S00368	01IN09C2	3.3	230.	20.	180.	88.	340.	15.	58.	56.	80.	20.	2.8	29.
S00369	01IN10C1	0.26	38.	6.2	130.	28.	1300.	4.3	40.	36.	25.	6.9	1.3	29.
S00370	01IN10C2	3.7	260.	18.	280.	87.	300.	18.	75.	100.	93.	20.	4.2	14.
S00371	01IN10C3	4.0	230.	20.	280.	95.	180.	22.	160.	96.	410.	21.	1.8	20.
S00372	01IN11C1	3.6	210.	18.	340.	97.	190.	22.	170.	120.	240.	20.	2.3	34.
S00373	01IN11C2	3.0	210.	21.	240.	97.	280.	18.	64.	130.	210.	21.	2.9	37.
S00374	01IN11C3	2.4	180.	16.	230.	74.	270.	17.	110.	100.	82.	17.	1.9	14.
S00375	01IN13C1	4.0	280.	16.	270.	68.	260.	19.	69.	130.	31.	16.	3.3	18.
S00376	01IN13C2	2.3	140.	13.	360.	65.	290.	12.	140.	190.	270.	13.	2.1	15.
S00049	71477A			19.		81.	44.	3.0	62.		<30.	26.		14.
S00050	71477B			20.		85.	45.	3.0	43.		<30.	23.		12.
S00136	NAS-0021	6.5	64.	11.	120.	52.	260.	28.	80.	63.	160.	14.	3.5	40.
S00137	NAS-0025	4.0	73.	14.	140.	68.	820.	32.	100.	68.	90.	15.	3.2	91.
S00138	NAS-0028	3.0	95.	16.	120.	69.	310.	24.	81.	74.	240.	20.	2.2	45.
S00139	NAS-0031	3.1	110.	15.	130.	83.	280.	18.	87.	44.	380.	16.	2.2	39.
S00140	NAS-0032	3.8	150.	21.	150.	91.	350.	23.	72.	84.	150.	26.	2.5	37.
S00141	NAS-0033	3.6	120.	15.	200.	74.	280.	24.	100.	68.	360.	18.	2.8	26.
S00142	NAS-0036	1.9	76.	13.	200.	77.	570.	14.	58.	33.	200.	16.	0.6	34.
S00143	NAS-0037	3.0	110.	19.	140.	86.	420.	18.	54.	43.	110.	22.	1.6	20.
S00144	NAS-0041	3.3	120.	17.	93.	87.	310.	18.	49.	13.	53.	20.	2.3	14.
S00145	NAS-0043	3.4	100.	20.	150.	92.	290.	20.	58.	50.	91.	25.	2.2	19.
S00146	NAS-0045	3.0	140.	15.	170.	71.	410.	18.	56.	42.	120.	18.	2.4	19.
S00147	NAS-0046	3.3	100.	15.	150.	65.	300.	23.	55.	54.	76.	16.	2.6	25.
S00148	NAS-0050	3.7	150.	17.	210.	83.	230.	28.	100.	88.	220.	19.	2.4	26.

Table C1. Continued.

Sample no.	Geol. no.	Be (ppm)	B (ppm)	Sc (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00149	NAS-0054	2.8	130.	15.	190.	70.	290.	26.	83.	84.	140.	16.	3.4	51.
S00150	NAS-0057	3.0	100.	17.	650.	110.	200.	11.	110.	95.	540.	19.	2.9	25.
S00151	NAS-0059	3.4	140.	18.	150.	78.	260.	24.	75.	110.	99.	22.	2.8	42.
S00152	NAS-0061	2.8	110.	17.	430.	93.	330.	17.	95.	72.	370.	17.	2.7	30.
S00153	NAS-0062	2.5	170.	17.	180.	83.	350.	14.	54.	71.	88.	19.	2.2	17.
S00154	NAS-0065	2.9	130.	17.	530.	100.	230.	12.	110.	91.	550.	18.	2.1	33.
S00155	NAS-0067	3.2	160.	16.	160.	69.	220.	21.	79.	110.	110.	18.	3.3	28.
S00156	NAS-0068	2.0	89.	11.	250.	56.	340.	11.	89.	100.	100.	14.	<1.0	12.
S00157	NAS-0070	2.5	110.	17.	600.	110.	340.	13.	100.	65.	300.	21.	3.8	23.
S00158	NAS-0072	3.0	160.	19.	260.	94.	340.	20.	97.	98.	270.	20.	3.7	22.
S00175	NAS-0084	3.4	110.	18.	280.	120.	250.	15.	80.	14.	330.	20.	3.6	8.1
S00176	NAS-0087	3.4	110.	16.	160.	79.	310.	33.	66.	55.	90.	18.	4.2	24.
S00177	NAS-0090	2.6	140.	12.	220.	59.	290.	24.	100.	67.	270.	14.	3.2	49.
S00178	NAS-0091	3.2	140.	15.	130.	61.	230.	22.	74.	66.	78.	15.	<3.4	24.
S00179	NAS-0092	3.1	170.	17.	190.	76.	230.	16.	81.	88.	170.	18.	2.8	13.
S00180	NAS-0093	2.8	120.	13.	650.	76.	140.	11.	130.	69.	330.	14.	<3.4	40.
S00181	NAS-0094	3.6	210.	18.	180.	81.	240.	26.	100.	83.	88.	20.	<3.4	29.
S00182	NAS-0095	2.9	170.	17.	370.	84.	200.	16.	130.	81.	280.	18.	<3.4	27.
S00183	NAS-0096	2.2	110.	14.	370.	74.	260.	8.7	120.	140.	290.	12.	2.0	13.
S00184	NAS-0102	3.0	99.	17.	270.	77.	230.	31.	90.	110.	400.	18.	<3.2	23.
S00185	NAS-0103	2.7	130.	14.	170.	66.	210.	25.	82.	48.	77.	18.	<3.3	40.
S00186	NAS-0104	2.3	220.	20.	220.	100.	250.	16.	92.	100.	99.	20.	3.1	17.
S00187	NAS-0106	2.3	100.	18.	100.	100.	270.	15.	37.	13.	61.	19.	<3.7	18.
S00188	NAS-0107	2.4	87.	16.	220.	84.	240.	33.	93.	98.	190.	19.	<3.2	34.
S00189	NAS-0110	2.5	100.	18.	180.	92.	320.	31.	64.	50.	90.	22.	3.1	28.
S00190	NAS-0112	2.1	110.	17.	150.	83.	460.	16.	57.	49.	74.	23.	3.3	16.
S00191	NAS-0114	2.1	180.	14.	570.	110.	410.	17.	130.	86.	450.	15.	<3.4	40.
S00192	NAS-0115	2.6	250.	18.	170.	82.	240.	24.	91.	89.	210.	16.	<3.4	33.
S00193	NAS-0116	2.1	250.	17.	210.	82.	270.	15.	82.	75.	160.	19.	<3.5	17.
S00194	NAS-0117	1.4	130.	13.	310.	77.	310.	11.	120.	140.	240.	11.	1.8	14.
S00195	NAS-0119	2.0	150.	14.	350.	73.	250.	19.	94.	80.	190.	20.	<3.4	36.
S00196	NAS-0120	2.5	170.	15.	150.	74.	240.	15.	79.	68.	140.	18.	<3.5	23.
S00197	NAS-0121	2.3	180.	15.	200.	76.	260.	15.	86.	61.	160.	19.	<3.5	20.
S00198	NAS-0123	2.5	190.	18.	260.	100.	370.	19.	92.	55.	160.	20.	2.6	31.
S00199	NAS-0124	2.4	210.	15.	140.	72.	270.	21.	81.	84.	110.	22.	<3.4	47.
S00200	NAS-0125	2.1	230.	20.	170.	92.	370.	18.	77.	64.	270.	20.	2.6	14.
S00201	NAS-0126	1.8	130.	13.	250.	69.	330.	13.	110.	110.	140.	15.	1.9	14.
S00202	NAS-0129	2.3	120.	13.	390.	78.	140.	12.	130.	60.	380.	16.	<3.4	30.
S00203	NAS-0130	2.8	150.	16.	150.	74.	290.	23.	76.	82.	420.	19.	<3.3	55.
S00204	NAS-0131	1.7	100.	12.	190.	61.	350.	11.	86.	100.	210.	13.	<1.0	15.
S00205	NAS-0134	1.9	110.	17.	90.	76.	1140.	14.	38.	16.	56.	16.	1.9	9.5
S00206	NAS-0135	2.2		20.	140.	93.	400.	20.	65.	29.	88.	22.	<3.5	17.
S00207	NAS-0138	2.6		20.	160.	88.	310.	23.	47.	42.	88.	24.	<3.5	21.
S00208	NAS-0141	3.7		20.	340.	100.	230.	20.	110.	63.	190.	22.	<3.6	20.
S00209	NAS-0144	2.9		15.	200.	70.	260.	23.	80.	59.	100.	16.	<3.6	26.
S00210	NAS-0145	2.5		17.	190.	73.	350.	14.	58.	57.	64.	18.	<3.6	18.
S00211	NAS-0148	3.0		16.	190.	83.	380.	28.	87.	80.	130.	17.	<3.6	45.
S00212	NAS-0151	3.6		20.	330.	97.	240.	21.	120.	71.	220.	23.	<3.6	70.
S00213	NAS-0153	3.4		19.	320.	90.	240.	21.	95.	56.	82.	20.	<3.6	23.

Sample no.	Geol. no.	Be (ppm)	B (ppm)	Sc (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00214	NAS-0156	3.2		16.	220.	74.	220.	30.	72.	55.	58.	17.	<3.3	35.
S00215	NAS-0159	3.1		17.	530.	110.	200.	15.	130.	76.	550.	20.	<3.4	36.
S00216	NAS-0161	3.1		20.	240.	89.	260.	23.	87.	64.	170.	22.	<3.4	25.
S00217	NAS-0162			19.		91.	230.	21.	100.		77.	22.		18.
S00218	NAS-0165	3.2		18.	240.	85.	320.	22.	62.	44.	180.	21.	<3.4	28.
S00219	NAS-0166	2.8		17.	440.	110.	180.	11.	86.	66.	340.	19.	<3.4	21.
S00220	NAS-0167	2.9		19.	180.	82.	300.	20.	62.	53.	79.	22.	<3.5	22.
S00221	NAS-0170	3.1		16.	210.	78.	310.	29.	71.	58.	130.	20.	<3.4	37.
S00222	NAS-0174	3.2		20.	200.	93.	250.	31.	52.	50.	110.	21.	<3.4	27.
S00223	NAS-0176	2.8		15.	190.	70.	380.	35.	63.	64.	110.	17.	<3.3	44.
S00224	NAS-0177	3.2		20.	200.	86.	250.	25.	70.	48.	88.	22.	<3.4	24.
S00225	NAS-0181	3.5		20.	200.	88.	290.	28.	79.	74.	170.	22.	<3.4	32.
S00226	NAS-0183	2.9		16.	220.	70.	220.	25.	93.	53.	200.	18.	<3.4	32.
S00227	NAS-0185	3.0		19.	280.	98.	280.	19.	82.	60.	210.	22.	<3.5	24.
S00228	NAS-0189	3.1		15.	220.	70.	550.	30.	83.	55.	160.	17.	<3.3	45.
S00229	NAS-0192	3.3		17.	180.	72.	300.	23.	65.	65.	91.	21.	<3.4	30.
S00230	NAS-0193	1.4		12.	160.	54.	350.	8.7	49.	70.	38.	11.	<3.5	8.1
S00231	NAS-0195	3.1		22.	160.	100.	420.	25.	44.	33.	95.	25.	<3.5	22.
S00232	NAS-0196	3.1		19.	170.	91.	340.	27.	61.	39.	97.	22.	<3.4	37.
S00233	NAS-0198	3.4		19.	200.	89.	330.	30.	81.	52.	160.	23.	<3.4	33.
S00234	NAS-0202	3.8		22.	190.	98.	320.	26.	72.	60.	120.	27.	<3.5	36.
S00235	NAS-0206	3.1		15.	200.	71.	420.	27.	83.	64.	93.	19.	<3.3	45.
S00236	NAS-0207	2.6		15.	340.	82.	290.	15.	71.	51.	370.	18.	<3.3	37.
S00237	NAS-0208	2.9		19.	290.	87.	250.	16.	97.	99.	270.	21.	<3.4	32.
S00238	NAS-0212	3.6		18.	210.	82.	300.	30.	83.	59.	150.	22.	<3.3	37.
S00239	NAS-0213	3.3	190.	17.	380.	120.	150.	11.	140.	89.	560.	19.	3.4	28.
S00240	NAS-0214	4.2	190.	20.	200.	92.	220.	27.	93.	94.	180.	24.	2.5	28.
S00241	NAS-0215	1.5	96.	11.	290.	59.	340.	14.	97.	130.	190.	15.	<0.1	20.
S00242	NAS-0216	3.3	160.	20.	180.	96.	260.	23.	61.	100.	81.	24.	2.2	20.
S00243	NAS-0219	3.2	130.	19.	180.	96.	320.	24.	80.	120.	220.	22.	2.1	33.
S00244	NAS-0222	3.6	160.	18.	130.	96.	300.	19.	60.	33.	60.	20.	1.5	4.9
S00245	NAS-0224	3.7	150.	20.	220.	95.	290.	23.	76.	120.	92.	24.	2.1	19.
S00246	NAS-0227	4.0	160.	19.	250.	97.	270.	24.	75.	110.	130.	23.	1.8	26.
S00247	NAS-0229	5.4	210.	20.	150.	97.	320.	25.	97.	130.	130.	23.	2.1	25.
S00248	NAS-0233	4.1	170.	20.	210.	100.	280.	21.	95.	120.	220.	25.	2.1	27.
S00249	NAS-0234	3.3	130.	19.	200.	100.	420.	24.	100.	110.	190.	22.	2.3	22.
S00250	NAS-0237	3.2	150.	20.	180.	90.	380.	19.	75.	120.	120.	26.	1.6	13.
S00251	NAS-0240	4.6	170.	18.	180.	87.	470.	27.	90.	120.	240.	21.	2.0	44.
S00252	NAS-0242	4.2	190.	19.	170.	88.	330.	26.	77.	100.	150.	22.	2.6	27.
S00253	NAS-0246	3.7	190.	16.	270.	81.	610.	28.	95.	140.	160.	17.	1.8	39.
S00254	NAS-0247	3.7	210.	14.	170.	64.	340.	21.	73.	170.	140.	15.	1.6	23.
S00255	NAS-0249	1.5	120.	12.	210.	63.	340.	12.	120.	150.	210.	11.	2.4	15.
S00256	NAS-0252	2.8	170.	19.	190.	86.	620.	26.	110.	100.	250.	19.	2.6	38.
S00257	NAS-0253	2.6	160.	16.	230.	87.	330.	14.	100.	80.	140.	18.	2.4	17.
S00269	NAS-0292	5.2	140.	16.	210.	75.	240.	25.	70.	130.	180.	17.	2.4	28.
S00270	NAS-0295	4.1	170.	18.	200.	80.	280.	23.	100.	86.	110.	20.	2.4	24.
S00271	NAS-0298	4.4	180.	20.	220.	96.	270.	32.	98.	93.	180.	23.	1.9	36.
S00272	NAS-0300	4.5	160.	18.	250.	85.	330.	32.	93.	140.	200.	20.	2.7	34.
S00273	NAS-0307	5.4	170.	16.	250.	72.	290.	22.	73.	99.	80.	16.	2.7	33.

Table C1. Continued.

Sample no.	Geol. no.	Be (ppm)	B (ppm)	Sc (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	Ge (ppm)	As (ppm)
S00274	NAS-0309	5.2	160.	16.	220.	77.	300.	25.	93.	94.	170.	19.	3.2	32.
S00275	NAS-0314	5.4	130.	16.	170.	79.	290.	35.	75.	88.	150.	20.	2.4	31.
S00276	NAS-0317	5.6	140.	19.	180.	95.	320.	29.	75.	72.	150.	22.	2.8	25.
S00277	NAS-0320	5.1	140.	16.	200.	84.	260.	28.	88.	77.	180.	21.	2.8	33.
S00278	NAS-0322	4.7	130.	15.	220.	69.	570.	27.	98.	140.	360.	17.	1.8	34.
S00279	NAS-0325	4.7	150.	16.	140.	89.	200.	21.	72.	98.	170.	18.	1.7	35.
S00280	NAS-0331	4.3	150.	18.	180.	89.	300.	27.	89.	110.	120.	22.	2.2	30.
S00281	NAS-0335	3.0	160.	18.	200.	80.	380.	27.	110.	95.	240.	20.	2.4	40.
S00282	NAS-0338	4.8	180.	19.	150.	82.	600.	24.	90.	84.	140.	20.	1.7	33.
S00283	NAS-0343	5.0	160.	14.	240.	75.	720.	20.	120.	71.	140.	15.	2.5	33.
S00284	NAS-0346	4.3	130.	17.	230.	85.	400.	21.	110.	96.	150.	18.	2.8	21.
S00285	NAS-0348	3.6	120.	16.	220.	76.	310.	27.	94.	58.	130.	17.	1.9	31.
S00286	NAS-0351	4.5	120.	17.	250.	81.	290.	28.	62.	84.	130.	19.	2.5	35.
S00287	NAS-0355	3.4	140.	16.	210.	70.	380.	23.	110.	83.	160.	18.	1.7	40.
S00288	NAS-0359	5.8	180.	17.	200.	78.	390.	36.	100.	98.	150.	20.	2.0	45.
S00289	NAS-0360	4.2	200.	20.	360.	99.	280.	19.	130.	110.	190.	23.	3.1	29.
S00290	NAS-0361	3.9	160.	21.	170.	95.	320.	20.	58.	86.	89.	26.	2.4	17.
S00291	NAS-0366	3.2	120.	19.	170.	87.	390.	24.	78.	110.	130.	23.	2.8	27.
S00292	NAS-0369	3.6	130.	16.	170.	84.	390.	26.	81.	110.	160.	19.	2.2	30.
S00293	NAS-0370	5.7	170.	16.	190.	74.	280.	28.	99.	83.	120.	22.	1.7	34.
S00294	NAS-0377	4.7	150.	16.	150.	79.	230.	23.	57.	96.	120.	20.	2.3	19.
S00295	NAS-0380	4.5	150.	19.	210.	94.	260.	22.	74.	100.	160.	23.	2.0	21.
S00296	NAS-0383	5.7	180.	17.	180.	83.	260.	32.	89.	72.	160.	21.	3.1	27.
S00297	NAS-0389	4.4	170.	19.	190.	89.	440.	26.	86.	91.	140.	23.	2.2	27.
S00298	NAS-0393	4.7	210.	17.	210.	77.	250.	27.	110.	97.	190.	22.	2.6	37.
S00299	NAS-0396	3.1	170.	17.	390.	88.	240.	15.	100.	130.	220.	20.	2.8	19.
S00300	NAS-0398			12.		59.	280.	28.	100.		84.	15.		43.
S00301	NAS-0402	2.9	180.	20.	240.	95.	330.	15.	67.	100.	100.	24.	2.3	12.
S00302	NAS-0409	4.5	150.	20.	210.	95.	390.	26.	91.	74.	190.	23.	2.5	58.
S00303	NAS-0413	3.6	160.	20.	190.	98.	280.	21.	78.	44.	130.	25.	2.4	17.
S00304	NAS-0415	3.9	140.	17.	300.	81.	410.	25.	120.	62.	210.	18.	2.6	29.
S00305	NAS-0417	3.8	120.	18.	240.	86.	590.	24.	120.	67.	170.	21.	2.1	32.
S00306	NAS-0421	3.0	150.	15.	250.	74.	340.	24.	96.	61.	160.	15.	2.0	34.
S00307	NAS-0424	3.2	190.	18.	300.	87.	290.	18.	100.	98.	210.	20.	1.9	23.
S00308	NAS-0427	2.4	150.	14.	330.	81.	230.	12.	130.	68.	520.	14.	2.4	28.
S00309	NAS-0431	5.1	210.	15.	380.	76.	650.	18.	120.	87.	210.	18.	2.7	31.
S00310	NAS-0434	4.6	190.	13.	300.	65.	190.	26.	120.	79.	240.	15.	2.5	47.
S00311	NAS-0438	1.9	86.	11.	280.	72.	200.	11.	96.	95.	150.	12.	2.6	15.
S00312	NAS-0444	4.5	170.	19.	250.	84.	240.	21.	69.	110.	150.	23.	2.1	17.
S00313	NAS-0447	4.1	180.	14.	230.	72.	310.	21.	69.	67.	160.	17.	2.3	24.
S00314	NAS-0451	4.8	190.	17.	370.	83.	710.	17.	78.	92.	160.	19.	2.5	20.
S00315	NAS-0454	6.5	170.	20.	230.	87.	310.	21.	74.	120.	140.	26.	2.0	19.
S00316	NAS-0459	5.4	140.	15.	230.	73.	210.	32.	62.	73.	120.	20.	1.7	63.
S00317	NAS-0460	5.2	160.	21.	220.	93.	310.	20.	83.	68.	240.	25.	2.1	18.
S00318	NAS-0464	4.7	160.	18.	190.	78.	290.	21.	61.	100.	130.	21.	2.1	33.
S00319	NAS-0466	4.9	200.	19.	180.	89.	270.	23.	64.	83.	160.	23.	2.3	13.
S00320	NAS-0470	4.4	180.	17.	180.	77.	290.	15.	60.	91.	200.	21.	2.3	15.
S00321	NAS-0473	4.3	220.	17.	200.	110.	320.	23.	83.	110.	130.	19.	2.1	37.
S00322	NAS-0476	1.5	86.	9.3	240.	46.	470.	8.1	66.	170.	150.	9.3	2.1	10.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00001	01KY01C1	2.	5.	110.	110.	120.	170.		2.4	4.9	5.4	400.	35.	65.
S00002	01KY02C1	<2.	4.5	95.	130.	130.	170.		<1.5	3.3	4.5	430.	28.	59.
S00003	01KY03C1	<2.	4.	100.	190.	130.	150.		<1.5	5.6	5.1	490.	29.	63.
S00004	01KY04C1	1.	3.	150.	180.	140.	4.		4.7	1.8	6.5	600.	37.	68.
S00005	01KY05C1	<1.7	3.	130.	730.	170.	76.		<1.6	4.2	4.5	6800.	45.	160.
S00006	01KY06C1	<1.	<4.	190.	190.	170.	<1.		4.4	1.4	9.1	640.	42.	81.
S00007	01KY07C1	7.	5.	130.	230.	190.	210.		3.8	11.	7.4	480.	38.	73.
S00008	01KY08C1	<1.6	4.	160.	170.	180.	1.5		10.	2.0	7.8	470.	44.	78.
S00033	01KY08L1	5.	3.	170.	150.	160.	17.		8.3	3.0	8.3	440.	39.	72.
S00009	01KY09C1	<2.	3.6	130.	190.	180.	8.5		6.2	2.8	6.9	390.	36.	68.
S00034	01KY10L1	1.	3.4	110.	150.	170.	4.		5.5	0.8	6.3	360.	35.	61.
S00010	01KY10C1	2.	5.0	140.	130.	160.	23.		9.4	1.8	7.7	390.	37.	64.
S00035	01KY11L1	2.	<5.	120.	110.	160.	11.		6.0	1.0	5.8	350.	32.	55.
S00011	01KY11C1	3.3	3.	100.	130.	130.	23.		3.8	2.1	5.3	340.	33.	63.
S00012	01KY12C1	<4.	3.	77.	110.	100.	39.		4.5	2.8	4.2	270.	30.	48.
S00036	01KY12L1	5.6	<4.	87.	130.	91.	36.		4.2	2.5	4.0	270.	29.	50.
S00037	01KY13L1	8.	2.	84.	130.	100.	39.		4.4	4.1	4.0	280.	31.	50.
S00013	01KY13C1	8.	4.	93.	130.	120.	87.		4.0	6.7	4.0	350.	31.	50.
S00393	02KY01C1	<5.	4.	110.	78.	150.	160.	0.40	4.4	11.	5.4	430.	42.	73.
S00394	02KY02C1	<4.	<7.	110.	87.	140.	170.	0.10	4.6	4.4	5.0	410.	36.	66.
S00395	02KY03C1	<2.	<3.	150.	110.	230.	97.	<0.07	6.0	4.5	6.1	530.	44.	83.
S00396	02KY04C1	<2.	<3.	170.	120.	200.	43.	<0.09	7.5	2.4	7.2	570.	45.	85.
S00397	02KY05C1	<2.	<4.	180.	110.	160.	50.	<0.09	5.5	3.0	8.2	540.	42.	79.
S00398	02KY06C1	<3.	2.	130.	110.	130.	52.	<0.08	4.0	4.2	6.2	610.	33.	63.
S00399	02KY07C1	<2.	<4.	180.	120.	140.	33.	<0.09	5.3	3.3	7.5	550.	38.	68.
S00400	02KY08C1	<3.	6.	140.	100.	140.	17.	0.11	4.6	1.3	7.4	430.	38.	63.
S00401	02KY09C1	<3.	4.	84.	120.	88.	15.	0.29	4.2	1.0	4.9	420.	28.	46.
S00014	01IL01L2	<0.4	8.1	160.	69.	290.	<1.		7.0	0.6	8.1	350.	36.	79.
S00015	01IL03L1	<0.4	8.1	110.	84.	420.	<1.		1.7	0.5	4.9	360.	45.	98.
S00016	01IL04L1	<0.3	11.	110.	79.	440.	<1.		5.5	0.6	5.2	380.	37.	82.
S00017	01IL05L1	<0.8	8.5	170.	75.	380.	<1.		5.5	0.7	8.5	390.	40.	96.
S00018	01IL07L1	<0.3	<4.	100.	160.	270.	4.1		<1.7	0.3	5.0	330.	34.	79.
S00019	01IL09L1	<0.4	6.4	200.	85.	280.	<1.		7.6	0.5	10.	510.	39.	90.
S00020	01IL09L2	<0.4	7.	200.	82.	320.	0.7		6.7	0.6	10.	460.	43.	88.
S00021	01IL10L1	<0.4	5.8	190.	61.	260.	16.		4.5	0.9	11.	440.	34.	78.
S00022	01IL11L1	<0.3	8.4	270.	67.	260.	4.7		12.	0.9	13.	510.	35.	75.
S00023	01IL12L1	<0.3	8.5	230.	70.	190.	1.5		13.	1.2	14.	490.	39.	77.
S00024	01IL13L1	<0.3	9.4	270.	77.	160.	4.6		12.	1.2	13.	530.	37.	73.
S00025	01IL14L1	<0.7	6.7	220.	70.	180.	21.		8.1	1.7	12.	460.	34.	70.
S00026	01IL15L1	<1.8	7.	230.	62.	140.	82.		6.2	4.6	11.	450.	33.	65.
S00027	01IL16L1	<1.	<8.	210.	62.	180.	96.		5.6	6.6	9.5	440.	33.	66.
S00028	01IL17L1	1.	9.	170.	63.	200.	39.		5.7	3.1	6.4	450.	31.	65.
S00029	01IL18L1	<0.4	<7.	140.	61.	190.	58.		6.9	2.0	6.5	450.	32.	64.
S00030	01IL19L1	<2.	9.3	130.	62.	180.	78.		6.5	3.9	6.4	420.	34.	66.
S00031	01IL20L1	<1.	9.4	130.	80.	170.	22.		7.5	1.9	6.1	430.	34.	65.
S00032	01IL21L1	<3.	6.7	160.	68.	140.	29.		8.6	2.2	8.4	470.	36.	67.
S00038	02IL01L2	<0.2	4.	31.	180.	27.	9.5		<1.7	0.5	1.6	82.	17.	30.
S00051	02IL01C1	2.	<6.	140.	110.	250.	3.1		6.8	1.3	8.2	580.	41.	75.
S00052	02IL02C1	<1.5	4.	150.	95.	280.	0.9		6.6	0.9	7.9	410.	41.	79.

Table C1. Continued.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00053	02IL03C1	<2.	4.	110.	72.	170.	52.		4.4	3.9	6.5	340.	34.	65.
S00054	02IL04C1	1.4	4.	120.	60.	160.	72.		3.1	5.5	6.2	330.	32.	63.
S00055	02IL04C2	<0.8	4.	130.	67.	170.	55.		5.2	4.2	6.4	360.	37.	68.
S00056	02IL05C1	1.6	3.	130.	77.	170.	88.		6.7	3.7	6.9	480.	38.	73.
S00039	02IL05L2	<0.4	<7.	170.	100.	180.	18.		7.6	1.8	7.2	540.	38.	76.
S00057	02IL06C1	1.	<4.	160.	98.	190.	76.		8.1	3.2	8.2	500.	43.	79.
S00040	02IL06L2	<0.2	<4.	150.	130.	210.	3.7		7.9	0.9	6.8	570.	39.	79.
S00058	02IL07C1	<1.3	2.	170.	110.	180.	19.		8.7	1.7	7.2	530.	38.	75.
S00059	02IL08C1	<2.	<5.	160.	110.	160.	39.		9.4	3.0	8.4	550.	41.	80.
S00041	02IL09L1	<0.3	<4.	<30.	120.	12.	5.5		<1.7	0.2	0.2	53.	6.	16.
S00042	03IL01L1	<0.4	<4.	110.	190.	98.	5.6		4.9	0.6	4.9	360.	31.	54.
S00043	03IL07L1	2.	<5.	130.	110.	160.	110.		3.5	3.8	5.2	390.	34.	57.
S00044	03IL12L1	<0.6	<4.	160.	110.	160.	75.		16.	3.7	6.5	490.	35.	68.
S00045	03IL20L1	2.	2.	200.	110.	170.	5.7		12.	2.1	9.7	460.	43.	79.
S00046	03IL20L3	1.	4.	180.	110.	160.	13.		8.3	1.9	7.9	460.	39.	74.
S00047	03IL23L1	2.	3.	130.	86.	130.	29.		4.9	2.3	6.6	340.	31.	55.
S00048	03IL26L1	7.	<5.	180.	87.	130.	50.		7.9	5.6	7.9	350.	30.	54.
S00096	04IL01C1	<2.	<1.	210.	86.	150.	<0.1		5.4	0.5	10.	400.	40.	75.
S00097	04IL02C1	<1.	<2.	180.	79.	170.	<0.1		4.6	0.4	9.1	410.	38.	75.
S00098	04IL03C1	<2.	<1.	190.	79.	160.	0.6		3.8	0.3	9.3	360.	38.	72.
S00099	04IL04C1	<1.	<2.	210.	87.	150.	<0.1		4.7	0.5	10.	390.	37.	73.
S00100	04IL05C1	<3.	<1.	190.	83.	150.	6.8		3.7	0.7	9.3	450.	37.	72.
S00101	04IL06C1	<1.	<2.	220.	83.	140.	1.2		4.4	0.5	10.	380.	37.	68.
S00102	04IL07C1	<1.	<2.	220.	90.	150.	<1.		4.7	0.5	11.	330.	40.	73.
S00103	04IL08C1	<1.	<3.	210.	89.	140.	0.4		4.6	0.4	10.	330.	38.	68.
S00104	04IL09C1	<2.	<2.	210.	86.	140.	0.3		5.2	0.4	11.	400.	39.	69.
S00105	04IL10C1	<2.	<3.	260.	86.	140.	0.5		5.6	0.5	13.	390.	38.	66.
S00106	04IL11C1	<2.	<2.	220.	83.	140.	1.2		4.2	0.4	11.	390.	37.	61.
S00107	04IL12C1	<1.	<2.	240.	82.	120.	1.6		5.1	0.4	11.	380.	35.	61.
S00108	04IL13C1	<2.	<1.	200.	82.	130.	5.7		5.7	0.7	9.5	390.	33.	59.
S00109	04IL14C1	<3.	<1.	230.	88.	150.	14.		5.2	1.4	12.	420.	34.	65.
S00110	04IL15C1	<1.	<2.	200.	88.	200.	8.9		5.5	0.9	8.0	600.	41.	84.
S00111	04IL16C1	<1.	<1.	210.	97.	210.	29.		5.5	1.0	9.0	570.	40.	78.
S00159	04IL17L1	<1.	1.	160.	91.	250.	15.		6.0	1.4	6.8	540.	44.	75.
S00112	04IL17C1	<2.	<2.	180.	95.	250.	36.		4.8	1.3	7.4	520.	43.	79.
S00113	04IL18C1	<3.	<1.	210.	89.	240.	<0.4		5.3	0.6	9.1	740.	45.	77.
S00114	04IL19C1	<1.	<2.	190.	85.	250.	<0.4		5.4	0.4	7.3	540.	44.	75.
S00160	04IL19L1	<1.	<3.	180.	94.	210.	6.2		7.9	0.9	7.9	540.	44.	76.
S00115	04IL20C1	<3.	<2.	230.	89.	200.	17.		6.8	1.9	10.	600.	45.	78.
S00116	04IL21C1	4.	<2.	200.	90.	150.	1.0		7.9	0.6	9.2	590.	40.	72.
S00117	04IL22C1	<1.	<2.	200.	87.	150.	3.2		7.0	0.8	8.2	560.	41.	71.
S00118	04IL23C1	<1.	<2.	200.	91.	160.	7.8		6.7	0.6	7.9	570.	39.	70.
S00119	04IL24C1	<1.	<2.	190.	96.	160.	5.5		6.7	0.8	8.1	570.	39.	69.
S00120	04IL25C1	<1.	<2.	190.	93.	150.	4.9		6.4	0.7	7.6	510.	38.	66.
S00121	04IL26C1	<1.	<1.5	190.	90.	180.	4.8		6.4	1.1	7.9	570.	43.	76.
S00161	04IL27L1	<1.	<3.	130.	99.	220.	6.4		4.9	0.7	6.2	440.	46.	68.
S00122	04IL27C1	<1.	<2.	100.	91.	84.	4.6		1.1	0.3	4.2	270.	26.	44.
S00123	04IL28C1	<1.	<1.	130.	87.	110.	2.8		2.6	0.3	5.5	330.	27.	46.
S00162	04IL29L1	<1.	<2.	53.	73.	170.	5.3		<1.7	0.2	2.6	150.	18.	29.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00124	04IL29C1	<1.	<2.	30.	66.	160.	6.2		<1.7	<0.2	1.3	88.	9.1	15.
S00125	04IL30C1	1.	<2.	32.	180.	31.	3.		<1.7	<0.1	1.4	70.	12.	21.
S00172	05IL01L1	<3.	<3.	190.	69.	150.	28.		6.4	3.2	8.2	480.	36.	65.
S00173	05IL01L2	<3.	<3.	150.	71.	180.	62.		6.4	2.2	7.0	420.	44.	76.
S00174	05IL01L3	<4.	<2.	170.	72.	170.	82.		6.8	3.5	7.8	450.	38.	76.
S00073	06IL04C1	<1.	<3.	160.	75.	260.	<1.		5.3	0.5	7.7	400.	34.	73.
S00074	06IL05C1	<1.	<2.	200.	76.	200.	<1.		8.8	0.3	13.	480.	39.	85.
S00075	06IL06C1	<1.	<2.	190.	73.	220.	<1.		6.1	0.5	8.5	440.	35.	81.
S00076	06IL07C1	<1.	<1.	160.	70.	280.	<1.		5.3	0.5	9.1	400.	34.	79.
S00077	06IL08C1	<2.	<3.	180.	79.	170.	<1.		7.2	0.5	8.5	450.	38.	79.
S00078	06IL09C1	<1.	<3.	200.	80.	190.	<1.		7.3	0.4	10.	440.	42.	82.
S00079	06IL10C1	2.	<2.	200.	71.	170.	<1.		7.6	0.5	9.8	450.	37.	75.
S00080	06IL11C1	<1.	<2.	220.	76.	190.	<1.		9.1	0.4	14.	480.	36.	82.
S00163	06IL11L1	<1.	<2.	160.	74.	170.	<5.0		4.9	0.5	7.7	390.	34.	68.
S00081	06IL12C1	<3.	<2.	210.	75.	180.	<1.		7.2	0.5	10.	460.	35.	75.
S00082	06IL13C1	<1.	<2.	200.	84.	170.	<1.		7.1	0.6	13.	420.	35.	78.
S00164	06IL13L1	<1.	1.	200.	77.	170.	<5.0		6.8	0.5	11.	450.	41.	74.
S00165	06IL13L2	<1.	2.	230.	78.	170.	13.		7.5	1.1	12.	460.	43.	75.
S00166	06IL14L1	<1.	<3.	190.	100.	140.	1.6		5.6	0.5	10.	330.	38.	66.
S00083	06IL14C1	<1.	<2.	190.	92.	160.	1.9		6.8	0.6	9.6	370.	37.	72.
S00084	06IL15C1	<1.	<2.	210.	82.	170.	4.5		7.5	0.8	14.	410.	35.	77.
S00085	06IL16C1	<1.	<1.	190.	85.	160.	5.5		6.8	0.6	12.	390.	35.	71.
S00086	06IL17C1	<4.	<2.	170.	78.	160.	36.		6.3	1.7	8.9	380.	33.	68.
S00087	06IL18C1	1.	<1.	190.	74.	150.	27.		8.0	1.6	12.	410.	32.	69.
S00088	06IL19C1	<3.	<4.	250.	67.	140.	66.		6.4	4.6	9.0	410.	34.	59.
S00167	06IL19L1	<2.	<2.	180.	61.	150.	89.		5.6	5.6	8.7	490.	41.	70.
S00089	06IL20C1	<3.	2.	160.	64.	200.	120.		6.1	9.8	6.1	490.	35.	66.
S00168	06IL21L1	<2.	<2.	150.	77.	200.	62.		4.5	5.3	6.3	430.	35.	71.
S00090	06IL21C1	<2.	<2.	230.	70.	180.	14.		7.3	3.7	7.5	590.	42.	75.
S00169	06IL22L1	<1.	<1.	180.	76.	170.	17.		6.4	1.9	8.6	480.	40.	75.
S00091	06IL22C1	<2.	<3.	250.	73.	170.	12.		7.9	2.1	8.3	620.	40.	72.
S00092	06IL23C1	<2.	<2.	240.	81.	130.	19.		8.8	2.0	7.9	610.	40.	60.
S00093	06IL24C1	<2.	<1.	170.	75.	260.	2.3		4.3	0.7	6.1	420.	33.	58.
S00170	06IL25L1	<2.	<1.	170.	77.	210.	<6.0		6.0	0.6	8.2	410.	38.	70.
S00094	06IL25C1	<3.	<1.	240.	75.	180.	8.7		7.4	2.0	9.0	530.	39.	71.
S00171	06IL25L2	<3.	1.	85.	89.	86.	8.		<1.7	1.2	4.2	210.	23.	43.
S00126	07IL01L1	<0.5	<3.	21.	150.	19.	16.		<1.7	0.4	1.0	40.	14.	14.
S00127	07IL01L2	12.	7.	190.	100.	170.	56.		17.	6.9	13.	440.	44.	67.
S00128	07IL01L3	<0.5	<4.	130.	200.	140.	<6.0		5.6	1.3	6.7	410.	43.	63.
S00129	07IL02L1	<2.	4.	150.	92.	250.	<6.0		7.1	0.8	8.3	440.	43.	63.
S00130	07IL02L2	<3.	<5.	69.	420.	88.	<15.		<1.7	1.8	3.5	190.	39.	56.
S00131	07IL03L1	<3.	6.	140.	84.	260.	6.0		6.4	0.8	7.8	450.	48.	69.
S00132	07IL04L1	<2.	<5.	150.	85.	200.	83.		6.8	4.4	7.4	490.	46.	73.
S00133	07IL04L2	<2.	4.	150.	85.	180.	65.		7.9	3.6	6.8	500.	46.	73.
S00134	07IL05L1	<1.	3.4	8.	80.	35.	6.3		<1.7	1.2	0.4	30.	7.2	12.
S00135	09IL01L3	<3.	<4.	150.	80.	130.	25.		6.8	5.2	6.7	490.	34.	58.
S00323	10IL01L1	<3.	<4.	180.	100.	140.	77.	<0.09	7.0	6.2	8.2	550.	38.	70.
S00324	10IL01L2	<3.	<3.	160.	98.	190.	88.	0.07	6.7	3.5	7.7	490.	39.	71.
S00325	10IL01L3	<2.	<4.	61.	91.	180.	12.	<0.07	<2.9	0.6	2.7	270.	22.	43.

Table C1. Continued.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00326	10IL01L4	<2.	<3.	49.	190.	46.	7.9	<0.07	<3.6	0.5	2.8	160.	23.	33.
S00327	10IL01L5	<2.	<3.	25.	110.	49.	12.	<0.07	<2.9	0.2	1.3	74.	17.	26.
S00328	10IL01L6	<3.	<3.	78.	120.	98.	15.	<0.07	<3.0	0.7	4.3	180.	23.	37.
S00329	10IL01L7	<2.	<3.	<20.	84.	86.	<10.	<0.10	<3.5	0.1	0.3	35.	6.6	8.0
S00330	11IL02C1	6.	<5.	170.	500.	150.	90.	0.15	9.3	6.9	6.3	580.	41.	82.
S00331	11IL03C1	<3.	<4.	220.	260.	130.	85.	0.17	7.9	6.1	2.2	360.	40.	71.
S00377	11IL04L1	<4.	<3.	97.	1600.	150.	75.	<0.09	5.2	6.4	0.8	190.	51.	84.
S00378	11IL04L*	<2.	<2.	60.	5600.	110.	47.	<0.12	8.9	5.6	1.6	510.	240.	370.
S00332	11IL04C1	5.	<3.	140.	290.	160.	43.	0.21	6.2	6.6	1.5	350.	43.	76.
S00333	11IL05C1	<1.	<2.	200.	180.	210.	<8.7	<0.04	6.9	1.9	3.6	730.	43.	78.
S00334	11IL06C1	<1.	<2.	160.	190.	240.	<7.3	<0.07	8.9	2.2	1.2	320.	45.	75.
S00335	11IL07C2	<2.	<3.	200.	180.	220.	<7.5	<0.08	9.9	2.3	4.5	470.	51.	95.
S00336	11IL08C1	<3.	<2.	170.	160.	270.	<7.6	<0.07	6.7	1.8	3.7	390.	43.	77.
S00337	11IL09C1	<4.	<2.	150.	830.	390.	<6.8	<0.07	6.6	3.7	0.3	1000.	56.	95.
S00338	11IL10C1	<1.	<2.	140.	320.	300.	<6.3	<0.07	5.2	14.	0.3	200.	40.	72.
S00379	11IL10L1	<3.	<2.	160.	260.	160.	<7.2	<0.07	5.7	2.5	1.1	380.	29.	53.
S00339	11IL11C1	<3.	<2.	200.	270.	210.	31.	<0.07	13.	3.6	1.0	290.	41.	73.
S00380	11IL11L1	<3.	<3.	200.	610.	220.	19.	<0.07	9.4	2.8	0.8	340.	40.	76.
S00340	11IL12C1	<2.	<3.	130.	360.	220.	120.	0.17	11.	11.	<0.6	210.	41.	71.
S00381	11IL12L1	<3.	<3.	180.	340.	200.	13.	<0.06	6.7	3.3	1.0	200.	36.	68.
S00341	11IL13C1	<5.	<4.	210.	180.	160.	130.	0.23	8.4	7.2	1.8	310.	39.	77.
S00342	11IL14C1	6.	<3.	210.	140.	140.	22.	0.21	7.7	11.	2.3	310.	41.	71.
S00343	11IL15C1	10.	<5.	170.	260.	130.	150.	0.56	9.2	6.0	3.1	360.	41.	76.
S00344	11IL16C1	5.	3.	130.	390.	90.	63.	0.34	3.6	8.0	0.5	130.	46.	75.
S00345	11IL17C1	<4.	<2.	250.	140.	150.	39.	0.15	6.6	3.5	3.0	330.	41.	75.
S00346	11IL17C2	<4.	<3.	150.	150.	140.	84.	0.25	6.1	8.6	1.0	160.	34.	54.
S00347	11IL18C1	<3.	<3.	280.	120.	140.	<6.8	<0.08	6.6	2.5	3.2	540.	40.	77.
S00348	11IL19C1	<3.	<3.	130.	370.	160.	6.7	0.16	<2.9	4.1	1.0	140.	32.	57.
S00349	11IL20C1	<3.	<5.	120.	680.	110.	18.	0.25	5.9	14.	0.8	130.	27.	47.
S00350	11IL21C1	<2.	<3.	150.	270.	250.	15.	<0.08	6.4	3.1	0.8	170.	34.	58.
S00402	12IL01C1	22.	<4.	180.	72.	170.	51.	1.8	5.9	14.	10.	440.	48.	67.
S00403	12IL01C2	13.	<4.	170.	82.	190.	22.	0.36	11.	4.8	9.5	460.	47.	66.
S00404	12IL01C3	16.	<3.	150.	80.	130.	26.	1.1	6.7	7.6	8.2	380.	39.	58.
S00405	12IL01C4	17.	<3.	150.	88.	170.	9.	0.56	4.8	8.4	8.7	410.	42.	63.
S00407	13IL04C1	<2.	<3.	150.	210.	140.	<10.	<0.08	17.	1.0	7.8	440.	40.	65.
S00408	13IL05C1	15.	<3.	180.	110.	210.	7.	0.43	8.8	4.8	10.	570.	41.	61.
S00409	13IL06C2	12.	<3.	160.	76.	200.	23.	0.45	6.9	5.7	8.3	440.	43.	59.
S00410	13IL07C2	12.	<3.	120.	98.	140.	67.	1.1	9.3	7.3	6.4	380.	37.	48.
S00411	13IL08C1	10.	<4.	120.	85.	190.	65.	0.46	5.9	9.0	6.5	430.	37.	57.
S00412	13IL09C1	<3.	<4.	140.	83.	130.	130.	<0.08	5.3	4.4	7.2	390.	38.	63.
S00413	13IL10C1	<4.	<5.	140.	86.	110.	120.	<0.06	6.3	3.8	6.5	450.	34.	53.
S00414	13IL11C2	<3.	<5.	140.	95.	170.	100.	<0.09	9.0	5.2	6.6	450.	39.	66.
S00415	13IL12C3	<3.	<4.	160.	100.	150.	61.	0.10	9.5	5.1	7.6	510.	40.	72.
S00416	13IL13C2	<3.	3.	110.	78.	130.	73.	<0.06	7.5	5.1	5.9	410.	34.	53.
S00417	13IL14C3	<3.	<4.	160.	110.	160.	73.	0.21	19.	5.0	8.5	550.	42.	69.
S00418	13IL15C2	<3.	<4.	160.	110.	170.	68.	0.15	7.0	4.5	8.2	560.	43.	73.
S00419	13IL16C2	<3.	<4.	180.	100.	140.	34.	0.17	8.0	5.1	9.0	570.	41.	70.
S00420	13IL17C4	<3.	<4.	140.	99.	170.	41.	0.14	11.	3.4	7.4	540.	41.	71.
S00421	13IL18C2	<4.	<3.	170.	98.	190.	47.	<0.09	8.7	2.9	8.0	520.	43.	78.

* Sample 11IL04L* is a dike in 11IL04L1.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00422	13IL19C1	<2.	<4.	150.	100.	190.	21.	0.14	9.2	2.2	7.6	470.	44.	79.
S00423	13IL20C1	<3.	<3.	160.	100.	190.	25.	<0.09	10.	2.1	8.5	510.	43.	74.
S00424	13IL21C2	5.	<3.	140.	95.	210.	44.	0.28	12.	4.1	7.9	500.	44.	73.
S00425	13IL22C2	<2.	3.	170.	100.	170.	8.	<0.14	15.	2.3	9.8	470.	44.	77.
S00426	13IL23C4	<3.	<4.	160.	72.	100.	6.	0.19	7.9	2.1	9.0	460.	35.	61.
S00427	13IL24C2	<2.	2.	120.	93.	89.	13.	0.14	11.	1.7	6.6	330.	29.	48.
S00428	13IL25C3	<3.	4.	80.	240.	54.	54.	0.56	8.4	3.3	4.0	250.	25.	35.
S00429	13IL26C3	<4.	<4.	92.	150.	86.	34.	0.20	8.4	1.9	4.7	230.	27.	38.
S00430	13IL27C1	<5.	<3.	97.	140.	88.	51.	0.43	7.5	2.2	5.2	230.	29.	45.
S00352	01IN01C1	25.	5.	170.	70.	160.	89.	3.7	5.4	12.	8.9	440.	50.	68.
S00353	01IN01C2	22.	3.	130.	68.	150.	40.	1.4	<4.1	11.	7.4	440.	40.	58.
S00354	01IN02C1	6.	<4.	140.	72.	130.	45.	0.22	3.7	4.9	6.9	480.	38.	59.
S00355	01IN03C1	<2.	<4.	140.	64.	110.	83.	0.12	5.7	3.4	6.2	370.	33.	58.
S00356	01IN03C2	<2.	<4.	150.	72.	130.	100.	<0.09	5.3	3.8	7.2	420.	36.	66.
S00357	01IN03C3	<4.	<5.	160.	75.	130.	120.	<0.08	4.1	4.2	6.8	430.	39.	72.
S00358	01IN04C1	<4.	<5.	130.	89.	130.	180.	0.11	4.1	4.4	5.7	470.	40.	73.
S00359	01IN04C2	<3.	<4.	120.	100.	170.	160.	<0.09	4.3	3.3	5.2	510.	39.	68.
S00360	01IN05C1	<2.	<4.	160.	100.	180.	45.	0.21	9.4	3.7	7.0	550.	42.	77.
S00361	01IN05C2	<2.	<4.	160.	110.	170.	46.	<0.11	9.3	2.9	7.1	560.	43.	78.
S00362	01IN05C3	<2.	3.	180.	110.	180.	54.	<0.11	9.6	2.7	7.5	540.	43.	77.
S00363	01IN07C1	<2.	<4.	190.	120.	150.	30.	<0.10	9.2	2.0	8.2	610.	39.	71.
S00364	01IN07C2	<1.	<4.	200.	120.	140.	17.	<0.10	7.6	2.0	9.2	610.	40.	67.
S00365	01IN08C1	2.	3.	180.	130.	130.	40.	0.10	8.1	2.8	8.0	610.	39.	69.
S00366	01IN08C2	<3.	<4.	170.	110.	130.	65.	0.16	7.1	4.0	7.8	530.	36.	67.
S00367	01IN09C1	<4.	<5.	170.	110.	130.	140.	0.14	6.3	5.1	8.5	450.	41.	72.
S00368	01IN09C2	<3.	<3.	180.	150.	210.	14.	<0.08	6.8	1.5	8.4	570.	46.	79.
S00369	01IN10C1	<2.	<2.	54.	260.	70.	7.	0.16	6.8	0.4	2.4	240.	18.	33.
S00370	01IN10C2	<3.	<3.	150.	170.	160.	46.	<0.11	9.7	1.6	7.8	510.	42.	69.
S00371	01IN10C3	<5.	<4.	170.	140.	130.	120.	0.19	6.3	5.2	8.8	490.	41.	72.
S00372	01IN11C1	7.	<4.	140.	120.	140.	130.	0.46	6.0	5.8	7.9	460.	42.	76.
S00373	01IN11C2	<4.	<4.	160.	130.	130.	25.	0.51	6.4	3.0	9.7	420.	41.	68.
S00374	01IN11C3	<4.	<4.	130.	110.	120.	50.	0.23	4.5	2.4	7.8	380.	34.	56.
S00375	01IN13C1	4.	<3.	150.	120.	110.	15.	0.58	6.1	2.6	8.3	320.	33.	55.
S00376	01IN13C2	<5.	<5.	110.	230.	69.	49.	0.78	5.0	4.0	5.8	300.	29.	49.
S00049	71477A	<4.	<3.	180.			100.			3.5	9.4	640.	43.	70.
S00050	71477B	<3.	<2.	200.			50.			4.1	9.8	650.	45.	78.
S00136	NAS-0021	<2.	<5.	100.	99.	120.	110.		2.8	5.2	2.8	340.	30.	52.
S00137	NAS-0025	<2.	1.5	130.	61.	120.	100.		4.1	5.9	5.6	400.	33.	61.
S00138	NAS-0028	<2.	<4.	120.	110.	150.	61.		4.5	3.7	6.6	440.	40.	67.
S00139	NAS-0031	<3.	2.	130.	180.	160.	32.		5.3	3.1	6.5	610.	39.	62.
S00140	NAS-0032	<3.	3.0	170.	120.	150.	48.		7.1	3.4	7.9	610.	41.	74.
S00141	NAS-0033	<4.	<5.	140.	140.	130.	79.		5.3	4.7	7.2	400.	36.	63.
S00142	NAS-0036	<3.	<3.	120.	180.	160.	30.		<4.1	1.6	6.3	340.	33.	60.
S00143	NAS-0037	<2.	<2.	180.	110.	160.	26.		6.0	1.1	7.8	470.	38.	68.
S00144	NAS-0041	<1.	<2.	180.	70.	230.	<7.0		4.9	0.4	9.7	460.	40.	81.
S00145	NAS-0043	<1.	2.6	180.	80.	150.	37.		7.1	2.0	8.1	520.	39.	70.
S00146	NAS-0045	<2.	<3.	130.	110.	210.	34.		4.5	2.9	6.0	450.	39.	67.
S00147	NAS-0046	<2.	4.	120.	89.	110.	94.		4.1	2.8	5.9	410.	31.	56.
S00148	NAS-0050	<3.	<5.	150.	73.	140.	120.		5.6	5.8	7.4	430.	39.	67.

Table C1. Continued.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00149	NAS-0054	<3.	3.5	140.	240.	180.	110.		4.1	4.1	5.6	720.	34.	67.
S00150	NAS-0057	16.	<4.	160.	80.	150.	45.		8.3	9.4	8.7	430.	41.	61.
S00151	NAS-0059	<4.	2.7	150.	92.	130.	82.		5.3	4.3	7.4	540.	38.	70.
S00152	NAS-0061	11.	2.1	160.	130.	150.	52.		6.0	6.5	7.6	750.	35.	61.
S00153	NAS-0062	<2.	2.	150.	99.	190.	41.		5.3	2.2	7.1	450.	40.	68.
S00154	NAS-0065	15.	<3.	150.	120.	160.	53.		7.5	7.6	7.8	480.	45.	68.
S00155	NAS-0067	<4.	3.3	130.	98.	120.	89.		4.5	4.2	6.2	610.	38.	64.
S00156	NAS-0068	<4.	<3.	83.	210.	83.	52.		4.1	2.3	4.5	280.	31.	45.
S00157	NAS-0070	13.	<3.	140.	97.	200.	22.		8.3	5.9	7.3	420.	47.	68.
S00158	NAS-0072	<5.	<4.	170.	95.	170.	47.		7.1	3.7	7.9	460.	45.	74.
S00175	NAS-0084	<2.	<4.	200.	67.	210.	19.		8.9	0.9	12.	410.	38.	78.
S00176	NAS-0087	<2.	6.	140.	64.	160.	79.		5.9	3.2	6.7	440.	35.	67.
S00177	NAS-0090	<4.	4.	120.	120.	120.	110.		3.2	5.6	6.0	470.	33.	58.
S00178	NAS-0091	<3.	3.3	130.	96.	110.	70.		6.0	3.6	6.6	420.	29.	59.
S00179	NAS-0092	<4.	<5.	140.	110.	140.	27.		5.9	2.6	7.7	380.	32.	62.
S00180	NAS-0093	9.8	5.	120.	77.	150.	110.		5.4	9.7	5.6	340.	34.	53.
S00181	NAS-0094	<3.	<4.	150.	95.	130.	76.		6.2	4.3	7.2	520.	37.	70.
S00182	NAS-0095	6.	<5.	150.	78.	170.	98.		6.8	4.8	7.1	440.	38.	72.
S00183	NAS-0096	7.	<5.	110.	160.	190.	41.		6.0	7.4	5.2	260.	29.	48.
S00184	NAS-0102	<3.	5.	150.	70.	230.	110.		6.1	6.1	6.5	480.	39.	68.
S00185	NAS-0103	<3.	<5.	130.	100.	160.	100.		4.0	3.5	5.7	460.	36.	67.
S00186	NAS-0104	<4.	<4.	160.	150.	160.	24.		6.7	2.9	7.9	450.	39.	71.
S00187	NAS-0106	<1.	5.1	190.	67.	260.	<6.0		6.5	0.7	10.	460.	42.	88.
S00188	NAS-0107	<3.	6.	150.	55.	160.	120.		4.2	6.3	6.3	430.	35.	71.
S00189	NAS-0110	<3.	7.	140.	110.	200.	90.		4.9	3.7	6.5	480.	44.	80.
S00190	NAS-0112	<3.	<6.	130.	110.	230.	8.5		7.4	5.3	5.9	410.	43.	72.
S00191	NAS-0114	24.	2.7	120.	510.	140.	47.		6.6	11.	5.9	760.	50.	83.
S00192	NAS-0115	<3.	<3.	160.	130.	170.	69.		6.2	4.5	7.0	500.	40.	74.
S00193	NAS-0116	<3.	<2.	150.	110.	200.	55.		7.2	2.6	6.5	370.	43.	76.
S00194	NAS-0117	7.	<4.	100.	160.	93.	40.		<2.9	5.7	4.9	450.	29.	52.
S00195	NAS-0119	5.	<3.	120.	150.	160.	68.		4.4	4.7	5.4	440.	39.	64.
S00196	NAS-0120	<3.	<2.	130.	120.	140.	61.		6.7	3.0	7.8	420.	36.	64.
S00197	NAS-0121	<3.	<3.	120.	130.	160.	41.		6.1	3.1	5.8	420.	37.	67.
S00198	NAS-0123	9.	<7.	160.	140.	160.	17.		6.9	3.2	6.8	530.	49.	76.
S00199	NAS-0124	<3.	7.	130.	77.	140.	76.		4.5	4.7	5.6	460.	38.	69.
S00200	NAS-0125	<2.	<6.	170.	95.	200.	34.		5.5	2.4	8.9	590.	41.	79.
S00201	NAS-0126	5.	7.	100.	130.	100.	41.		5.0	3.1	4.7	270.	31.	55.
S00202	NAS-0129	8.	<5.	130.	98.	140.	140.		6.4	7.0	6.0	600.	34.	54.
S00203	NAS-0130	<4.	<4.	130.	100.	150.	73.		4.0	4.3	5.9	440.	38.	65.
S00204	NAS-0131	4.	2.7	100.	180.	89.	39.		4.2	3.4	4.9	250.	29.	47.
S00205	NAS-0134	<3.	<3.	130.	90.	160.	<6.0		4.8	1.1	7.1	280.	33.	58.
S00206	NAS-0135	<3.	<3.	170.	110.	180.	21.		5.7	2.3	8.4	470.	41.	70.
S00207	NAS-0138	<2.	<4.	180.	72.	160.	32.		6.3	2.3	8.4	540.	41.	68.
S00208	NAS-0141	<3.	<5.	200.	78.	150.	74.		16.	4.0	11.	430.	39.	64.
S00209	NAS-0144	<4.	<5.	130.	68.	110.	75.		12.	4.3	6.6	360.	32.	53.
S00210	NAS-0145	<2.	<3.	140.	120.	170.	36.		14.	1.8	6.3	440.	39.	67.
S00211	NAS-0148	<3.	<5.	140.	65.	170.	95.		8.6	4.0	6.5	450.	39.	65.
S00212	NAS-0151	<4.	<3.	200.	69.	160.	100.		14.	8.7	10.	450.	42.	69.
S00213	NAS-0153	<2.	<3.	190.	63.	160.	73.		15.	4.1	11.	440.	40.	67.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00214	NAS-0156	<4.	4.	140.	75.	150.	110.		5.3	4.4	6.4	400.	36.	60.
S00215	NAS-0159	14.	4.	170.	88.	200.	79.		9.3	8.0	8.3	430.	44.	66.
S00216	NAS-0161	<4.	3.	160.	97.	170.	63.		6.6	3.9	8.3	560.	40.	71.
S00217	NAS-0162	<3.	<4.	170.	120.		61.			3.0	7.9	480.	41.	68.
S00218	NAS-0165	<4.	2.8	150.	210.	160.	50.		7.0	3.2	7.9	470.	42.	72.
S00219	NAS-0166	14.	3.	160.	72.	160.	31.		7.4	6.4	8.1	420.	42.	58.
S00220	NAS-0167	<3.	<4.	150.	170.	180.	49.		6.6	2.5	8.0	410.	40.	70.
S00221	NAS-0170	<2.	3.8	130.	71.	160.	90.		7.4	4.2	6.9	500.	40.	68.
S00222	NAS-0174	<2.	<5.	160.	67.	200.	69.		7.7	4.1	8.0	510.	43.	73.
S00223	NAS-0176	<2.	<4.	120.	85.	180.	97.		3.9	4.5	6.3	440.	38.	70.
S00224	NAS-0177	<2.	2.9	160.	78.	180.	62.		8.1	3.1	7.6	550.	43.	77.
S00225	NAS-0181	<3.	<3.	190.	93.	170.	89.		7.1	3.4	7.8	520.	43.	70.
S00226	NAS-0183	<5.	<5.	130.	110.	140.	92.		4.8	4.1	6.2	480.	37.	60.
S00227	NAS-0185	5.	2.6	160.	110.	180.	50.		7.8	3.9	8.3	490.	43.	70.
S00228	NAS-0189	5.	6.	120.	110.	130.	120.		5.6	4.3	6.1	470.	38.	61.
S00229	NAS-0192	<3.	3.	150.	120.	150.	53.		7.0	3.8	7.2	520.	41.	66.
S00230	NAS-0193	<3.	<3.	98.	170.	73.	21.		6.1	1.9	4.8	290.	26.	37.
S00231	NAS-0195	<2.	<4.	210.	62.	130.	47.		7.7	2.7	11.	460.	39.	64.
S00232	NAS-0196	<3.	2.6	200.	62.	150.	68.		6.7	3.9	9.3	470.	37.	65.
S00233	NAS-0198	<3.	<3.	180.	73.	180.	86.		8.8	3.5	8.1	510.	39.	69.
S00234	NAS-0202	<3.	<2.	210.	110.	150.	44.		8.9	3.5	8.5	570.	40.	77.
S00235	NAS-0206	<4.	3.2	130.	79.	140.	150.		4.2	4.6	6.2	430.	36.	63.
S00236	NAS-0207	8.	<3.	130.	88.	150.	77.		5.3	7.2	6.7	500.	35.	58.
S00237	NAS-0208	5.	<3.	140.	150.	170.	98.		7.9	4.5	7.6	470.	41.	73.
S00238	NAS-0212	<5.	<4.	150.	88.	170.	130.		4.7	4.3	7.6	500.	40.	70.
S00239	NAS-0213	18.	<3.	160.	77.	170.	51.	1.5	6.5	9.4	8.4	470.	40.	65.
S00240	NAS-0214	<4.	3.4	180.	96.	160.	79.	0.20	6.7	4.0	8.1	520.	55.	74.
S00241	NAS-0215	4.	<3.	91.	170.	100.	27.		<4.2	3.7	4.7	350.	28.	45.
S00242	NAS-0216	<3.	2.3	200.	72.	160.	36.	0.12	7.0	2.8	9.7	450.	39.	68.
S00243	NAS-0219	<2.	3.	190.	77.	160.	71.	0.17	6.5	3.6	9.1	430.	38.	67.
S00244	NAS-0222	<1.	<3.	190.	61.	270.	<8.4	<0.08	5.9	0.6	10.	470.	43.	84.
S00245	NAS-0224	<2.	4.	190.	87.	190.	21.	<0.08	7.4	1.8	8.7	560.	44.	76.
S00246	NAS-0227	<3.	3.	190.	72.	150.	67.	0.16	7.3	3.5	9.5	460.	38.	63.
S00247	NAS-0229	<2.	4.	180.	72.	140.	67.	0.05	9.0	3.0	10.	490.	40.	68.
S00248	NAS-0233	<2.	2.	200.	75.	170.	44.	0.04	8.3	3.3	10.	470.	41.	73.
S00249	NAS-0234	<3.	<4.	180.	66.	160.	55.	<0.09	8.0	3.0	9.4	430.	38.	65.
S00250	NAS-0237	<2.	<3.	190.	80.	170.	19.	<0.03	8.7	1.6	8.2	590.	41.	73.
S00251	NAS-0240	<3.	4.	180.	62.	150.	76.	0.17	8.4	3.4	8.4	410.	36.	66.
S00252	NAS-0242	<3.	<3.	180.	73.	130.	70.	0.09	7.2	2.7	9.5	420.	37.	66.
S00253	NAS-0246	<5.	3.	150.	100.	120.	110.	0.26	4.3	6.4	6.2	440.	34.	56.
S00254	NAS-0247	4.	<3.	120.	88.	110.	62.	0.19	5.4	3.7	5.6	460.	30.	55.
S00255	NAS-0249	5.	2.	100.	150.	100.	35.	0.39	4.0	2.6	5.1	320.	28.	51.
S00256	NAS-0252	<5.	<3.	170.	81.	180.	55.	0.13	6.3	5.2	7.5	500.	41.	77.
S00257	NAS-0253	5.	2.	160.	78.	160.	53.	0.30	4.8	3.3	6.6	410.	36.	64.
S00269	NAS-0292	<4.	4.1	150.	87.	130.	64.	0.09	11.	3.4	5.8	400.	33.	57.
S00270	NAS-0295	<3.	2.2	170.	71.	200.	67.	0.10	6.6	2.8	7.0	450.	42.	67.
S00271	NAS-0298	<4.	2.9	200.	74.	170.	80.	<0.07	7.7	3.4	9.9	520.	41.	71.
S00272	NAS-0300	<4.	<5.	170.	87.	190.	100.	<0.08	9.0	3.7	7.3	460.	42.	70.
S00273	NAS-0307	<4.	<3.	150.	110.	160.	50.	<0.06	8.5	2.8	6.1	470.	40.	65.

Table C1. Continued.

Sample no.	Geol. no.	Se (ppm)	Br (ppm)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Mo (ppm)	Ag (ppm)	Sn (ppm)	Sb (ppm)	Cs (ppm)	Ba (ppm)	La (ppm)	Ce (ppm)
S00274	NAS-0309	<3.	<4.	160.	110.	160.	83.	<0.07	7.1	3.1	6.5	530.	40.	71.
S00275	NAS-0314	<3.	1.7	150.	63.	150.	85.	0.07	6.2	3.4	6.7	460.	38.	62.
S00276	NAS-0317	<3.	<3.	170.	100.	190.	69.	<0.05	7.8	3.3	8.0	560.	45.	77.
S00277	NAS-0320	7.	<4.	150.	72.	180.	110.	<0.06	6.0	3.4	6.8	500.	41.	64.
S00278	NAS-0322	<4.	<3.	130.	89.	190.	64.	0.15	8.6	3.2	5.2	470.	36.	59.
S00279	NAS-0325	<4.	2.	140.	93.	200.	50.	0.10	9.4	3.0	6.9	460.	38.	66.
S00280	NAS-0331	<5.	5.	150.	110.	150.	81.	0.09	9.7	3.3	7.2	510.	41.	70.
S00281	NAS-0335	<4.	<5.	150.	100.	160.	97.	<0.10	6.7	4.9	6.7	490.	41.	61.
S00282	NAS-0338	<3.	<3.	160.	88.	180.	55.	0.14	7.4	3.9	7.0	510.	42.	62.
S00283	NAS-0343	5.	<3.	130.	68.	120.	74.	0.28	7.3	4.3	6.0	340.	32.	50.
S00284	NAS-0346	<3.	<3.	170.	89.	110.	64.	0.09	12.	3.2	7.2	410.	39.	66.
S00285	NAS-0348	<5.	<4.	140.	93.	120.	100.	0.08	14.	3.5	6.2	510.	34.	57.
S00286	NAS-0351	<5.	<4.	160.	69.	130.	74.	0.09	21.	4.0	7.0	480.	35.	61.
S00287	NAS-0355	<4.	<3.	130.	86.	150.	85.	<0.08	6.5	3.5	5.8	480.	37.	64.
S00288	NAS-0359	<4.	<3.	150.	100.	120.	100.	0.09	5.8	4.6	6.9	470.	38.	63.
S00289	NAS-0360	6.	<3.	180.	100.	170.	71.	0.26	6.3	4.5	9.1	530.	46.	74.
S00290	NAS-0361	<3.	<3.	180.	100.	170.	32.	<0.08	7.7	1.3	8.8	570.	44.	72.
S00291	NAS-0366	<4.	<3.	170.	93.	180.	61.	0.09	17.	2.7	7.9	540.	45.	71.
S00292	NAS-0369	<4.	<3.	140.	78.	150.	85.	<0.08	17.	3.7	6.3	430.	38.	65.
S00293	NAS-0370	<5.	5.	150.	91.	140.	120.	<0.10	13.	3.7	6.9	470.	37.	63.
S00294	NAS-0377	<3.	<3.	140.	99.	160.	40.	<0.10	14.	2.8	6.6	460.	37.	58.
S00295	NAS-0380	<2.	<3.	190.	67.	150.	58.	<0.11	7.9	2.7	8.6	480.	44.	78.
S00296	NAS-0383	<2.	<5.	150.	82.	210.	99.	<0.10	10.	5.1	7.1	520.	38.	71.
S00297	NAS-0389	<3.	<4.	180.	210.	160.	71.	<0.09	7.2	3.4	8.1	460.	44.	85.
S00298	NAS-0393	<4.	4.	160.	100.	140.	98.	0.20	8.6	4.2	7.4	520.	37.	72.
S00299	NAS-0396	4.	<5.	160.	93.	150.	44.	0.38	7.5	3.3	7.6	430.	36.	69.
S00300	NAS-0398	<4.	<4.	120.	120.		84.			4.2	5.2	450.	32.	56.
S00301	NAS-0402	<4.	<3.	170.	110.	220.	12.	<0.09	5.9	1.7	8.1	530.	44.	79.
S00302	NAS-0409	<4.	1.	200.	84.	140.	92.	0.10	5.3	6.7	10.	520.	38.	64.
S00303	NAS-0413	<3.	<3.	200.	77.	150.	29.	<0.07	6.0	2.4	10.	390.	38.	61.
S00304	NAS-0415	<5.	<3.	150.	69.	140.	74.	0.13	6.4	4.3	8.2	410.	34.	65.
S00305	NAS-0417	<5.	<3.	140.	79.	110.	70.	0.05	5.7	5.2	7.0	510.	42.	80.
S00306	NAS-0421	5.	<4.	140.	120.	140.	110.	0.31	4.4	4.2	6.4	440.	34.	63.
S00307	NAS-0424	<5.	<3.	140.	130.	150.	52.	0.29	5.7	3.5	7.7	530.	39.	73.
S00308	NAS-0427	12.	3.1	130.	93.	150.	89.	1.2	6.8	9.1	6.6	380.	36.	66.
S00309	NAS-0431	5.	<4.	130.	120.	140.	52.	0.20	4.9	5.7	6.5	440.	35.	64.
S00310	NAS-0434	<4.	<5.	120.	130.	120.	120.	0.13	3.6	5.9	6.1	430.	34.	58.
S00311	NAS-0438	<4.	<1.	98.	250.	94.	44.		3.9	2.7	5.1	300.	27.	45.
S00312	NAS-0444	<2.	<3.	160.	92.	170.	34.	<0.06	7.6	2.1	7.8	570.	40.	72.
S00313	NAS-0447	3.	2.	130.	110.	140.	52.	<0.08	6.0	3.4	6.4	460.	32.	57.
S00314	NAS-0451	3.	<3.	150.	120.	150.	42.	0.12	11.	2.5	7.3	570.	38.	70.
S00315	NAS-0454	<2.	<4.	180.	110.	180.	22.	<0.07	11.	1.4	8.6	600.	45.	77.
S00316	NAS-0459	<4.	5.	150.	67.	160.	110.	<0.06	4.5	6.6	6.4	430.	37.	72.
S00317	NAS-0460	<2.	<3.	170.	88.	170.	21.	<0.07	6.5	1.9	8.5	590.	43.	75.
S00318	NAS-0464	<3.	<3.	160.	86.	180.	63.	0.08	7.0	2.5	7.0	510.	39.	73.
S00319	NAS-0466	<2.	<4.	170.	79.	190.	49.	<0.10	13.	2.2	7.5	550.	42.	77.
S00320	NAS-0470	<2.	<4.	160.	81.	240.	29.	<0.10	8.2	3.3	6.7	520.	42.	75.
S00321	NAS-0473	<3.	<3.	150.	130.	130.	73.	<0.09	7.8	3.8	7.2	490.	36.	65.
S00322	NAS-0476	<4.	<2.	74.	200.	81.	23.	0.25	6.5	2.2	4.0	240.	26.	41.

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00001	01KY01C1	5.6	1.6	1.1	5.6	2.3	0.5	3.0	0.9	42.	7.1	70.	
S00002	01KY02C1	5.6	1.3	0.8	4.4	1.9	0.3	3.0	0.8	20.	6.9	51.	
S00003	01KY03C1	6.2	1.3	0.9	4.8	2.0	0.4	3.1	0.8	50.	7.3	25.	
S00004	01KY04C1	5.8	1.3	0.8	4.7	2.2	0.4	3.0	1.0	27.	8.5	16.	
S00005	01KY05C1	22.	5.0	3.6	17.	5.3	0.9	4.5	0.7	36.	12.	42.	
S00006	01KY06C1	7.4	1.4	0.8	5.4	2.9	0.5	5.2	1.4	15.	14.	6.	
S00007	01KY07C1	9.0	1.9	1.0	6.4	2.8	0.6	3.5	0.8	32.	9.1	46.	
S00008	01KY08C1	10.	1.8	0.8	5.6	2.9	0.3	4.6	1.0	41.	11.	6.	
S00033	01KY08L1	7.1	1.7	1.2	6.5	2.8	0.4	4.2	1.4	36.	10.	16.	
S00009	01KY09C1	6.4	1.4	1.0	6.1	3.3	0.5	5.1	1.0	20.	12.	8.	
S00034	01KY10L1	5.2	1.1	0.7	5.3	1.9	0.4	3.9	1.0	10.	9.0	7.8	
S00010	01KY10C1	7.3	1.6	1.0	5.7	3.3	0.6	4.6	1.0	42.	10.	7.	
S00035	01KY11L1	6.0	1.4	0.8	6.8	2.4	0.4	3.6	1.0	15.	8.2	7.	
S00011	01KY11C1	7.6	1.6	1.1	6.8	3.1	0.5	3.3	0.7	46.	7.9	9.	
S00012	01KY12C1	6.2	1.5	0.7	5.5	2.6	0.4	2.3	0.6	34.	6.0	11.	
S00036	01KY12L1	8.0	1.4	0.8	6.5	2.4	0.5	2.2	0.7	9.8	5.8	13.	
S00037	01KY13L1	6.8	1.5	1.0	6.9	2.4	0.5	2.5	0.7	11.	5.5	15.	
S00013	01KY13C1	8.1	1.9	1.3	7.0	3.1	0.5	2.6	0.6	20.	6.2	25.	
S00393	02KY01C1	7.6	1.9	1.2	7.9	3.1	0.5	3.7	0.8	230.	7.9	75.	
S00394	02KY02C1	6.9	1.5	1.0	5.9	2.6	0.5	3.8	1.0	32.	8.7	61.	
S00395	02KY03C1	7.7	1.7	1.2	6.4	2.9	0.6	5.8	1.2	38.	11.	40.	
S00396	02KY04C1	7.9	1.6	1.0	6.1	2.8	0.5	5.5	1.4	35.	12.	18.	
S00397	02KY05C1	7.5	1.5	1.0	6.0	2.6	0.5	4.4	1.1	34.	11.	19.	
S00398	02KY06C1	6.7	1.5	0.9	4.8	2.3	0.4	3.2	0.9	36.	8.3	12.	
S00399	02KY07C1	6.9	1.5	1.2	5.3	2.4	0.6	3.8	1.0	45.	10.	17.	
S00400	02KY08C1	7.6	1.6	0.8	5.4	2.7	0.5	3.5	1.0	15.	10.	8.	
S00401	02KY09C1	5.7	1.2	0.7	3.7	1.8	0.4	2.3	0.6	24.	6.5	8.	
S00014	01IL01L2	5.1	1.1	0.8	5.6	2.4	0.4	6.7	1.3	7.7	12.	<5.	
S00015	01IL03L1	14.	3.0	1.8	9.8	3.8	0.7	11.	1.4	11.	12.	<6.	
S00016	01IL04L1	6.2	1.1	1.0	5.7	3.1	0.6	11.	1.5	<3.2	12.	<5.	
S00017	01IL05L1	6.5	1.5	1.1	6.5	3.3	0.6	11.	2.0	<3.2	15.	<5.	
S00018	01IL07L1	7.7	1.8	1.3	6.5	3.0	0.5	8.0	1.2	<3.2	9.5	<5.	
S00019	01IL09L1	6.0	1.2	1.0	4.5	2.6	0.4	7.6	1.6	<3.1	13.	<7.	
S00020	01IL09L2	6.7	1.3	0.9	6.3	2.8	0.6	8.6	1.5	<3.2	15.	<4.	
S00021	01IL10L1	5.9	1.3	1.1	4.1	2.4	0.4	7.1	1.7	45.	13.	<7.	
S00022	01IL11L1	6.3	1.2	0.9	3.9	2.3	0.4	5.1	1.7	49.	15.	<7.	
S00023	01IL12L1	5.5	1.4	0.8	5.5	2.4	0.4	5.4	1.6	42.	14.	<5.	
S00024	01IL13L1	5.9	1.1	0.9	4.5	2.2	0.4	4.8	1.5	34.	14.	7.	
S00025	01IL14L1	5.7	1.2	0.9	5.1	2.2	0.3	4.8	1.4	24.	12.	13.	
S00026	01IL15L1	5.0	1.3	0.9	5.1	2.3	0.4	4.0	1.2	52.	12.	25.	
S00027	01IL16L1	11.	1.4	1.2	6.7	3.0	0.4	6.1	1.6	74.	13.	36.	
S00028	01IL17L1	9.0	1.3	1.0	5.4	2.3	0.4	5.5	1.2	25.	10.	21.	
S00029	01IL18L1	8.3	1.2	0.7	4.7	1.9	0.3	4.4	1.0	27.	8.1	16.	
S00030	01IL19L1	6.2	1.3	0.8	6.0	1.9	0.4	3.7	1.0	25.	8.8	37.	
S00031	01IL20L1	5.2	1.1	0.7	5.3	2.3	0.4	5.6	1.2	22.	10.	7.	
S00032	01IL21L1	5.2	1.0	0.6	4.3	1.5	0.3	3.2	1.0	43.	9.1	12.	
S00038	02IL01L2	3.6	0.9	0.6	3.2	1.0	0.2	0.8	0.3	<4.8	1.9	<3.	
S00051	02IL01C1	6.2	1.0	0.6	5.0	2.1	0.3	5.5	1.3	16.	11.	3.	
S00052	02IL02C1	6.6	1.2	0.8	6.2	2.5	0.4	6.8	1.2	22.	13.	8.	

Table C1. Continued.

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00053	02IL03C1	6.8	1.1	0.7	5.4	1.9	0.3	3.7	0.8	24.	8.9	26.	
S00054	02IL04C1	5.7	1.1	0.6	5.3	2.0	0.3	4.0	1.0	38.	10.	28.	
S00055	02IL04C2	6.9	1.3	0.8	5.7	2.4	0.4	3.8	1.0	24.	11.	31.	
S00056	02IL05C1	8.4	1.6	0.9	6.7	2.3	0.4	3.4	1.0	22.	9.9	34.	
S00039	02IL05L2	5.9	1.2	0.7	4.6	2.4	0.4	5.0	1.6	18.	12.	13.	
S00057	02IL06C1	10.	1.6	0.9	6.2	2.4	0.4	4.5	1.2	34.	12.	30.	
S00040	02IL06L2	9.2	1.5	0.8	5.8	2.0	0.5	4.8	1.2	16.	11.	10.	
S00058	02IL07C1	7.6	1.2	0.8	5.2	2.2	0.4	4.0	1.2	30.	11.	<9.	
S00059	02IL08C1	8.4	1.3	0.9	5.6	2.3	0.4	3.5	1.2	42.	12.	21.	
S00041	02IL09L1	1.2	0.3	0.3	2.2	0.3	0.07	0.6	<0.1	<4.8	0.4	<5.	
S00042	03IL01L1	5.5	1.2	0.7	4.1	1.6	0.3	3.6	0.5	7.6	6.8	<4.	
S00043	03IL07L1	6.5	1.4	0.8	5.3	2.3	0.4	6.2	1.1	28.	9.8	46.	
S00044	03IL12L1	6.7	1.5	0.9	6.1	2.3	0.4	5.3	1.0	28.	11.	34.	
S00045	03IL20L1	7.4	1.5	1.0	5.7	2.9	0.4	7.2	1.3	26.	15.	13.	
S00046	03IL20L3	7.2	1.5	0.9	5.5	2.5	0.4	6.2	1.1	26.	12.	12.	
S00047	03IL23L1	5.1	1.0	0.6	4.0	1.5	0.3	4.9	0.7	46.	8.9	13.	
S00048	03IL26L1	7.6	1.7	1.1	6.1	2.8	0.6	3.9	0.8	22.	10.	17.	
S00096	04IL01C1	5.5	0.8	0.7	3.6	2.0	0.4	4.7	1.2	15.	12.	3.	
S00097	04IL02C1	5.9	1.0	0.7	4.1	2.4	0.4	5.3	1.3	22.	12.	<5.	
S00098	04IL03C1	5.8	1.0	1.2	3.8	2.4	0.5	5.2	1.3	13.	13.	<3.	
S00099	04IL04C1	5.4	1.0	0.7	3.6	2.1	0.4	4.9	1.3	10.	12.	<5.	
S00100	04IL05C1	5.7	1.1	0.8	3.3	2.1	0.3	4.8	1.1	17.	12.	4.	
S00101	04IL06C1	5.3	1.0	0.7	3.4	2.1	0.4	5.2	1.2	11.	13.	<5.	
S00102	04IL07C1	5.3	1.0	0.7	3.4	2.2	0.4	5.2	1.3	26.	14.	<5.	
S00103	04IL08C1	5.5	0.9	0.6	3.1	1.9	0.3	4.3	1.2	22.	12.	<5.	
S00104	04IL09C1	5.4	1.0	0.6	3.4	1.8	0.4	4.5	1.2	22.	11.	<6.	
S00105	04IL10C1	5.3	1.0	0.7	3.2	2.1	0.4	4.9	1.4	22.	14.	<5.	
S00106	04IL11C1	5.0	1.0	0.7	3.3	2.1	0.4	4.6	1.3	15.	12.	4.	
S00107	04IL12C1	5.1	1.0	0.7	3.2	2.0	0.4	4.3	1.2	14.	12.	<6.	
S00108	04IL13C1	4.9	0.9	0.5	3.3	1.4	0.3	3.6	0.8	19.	11.	<5.	
S00109	04IL14C1	4.7	1.0	0.6	3.5	1.7	0.4	5.1	0.9	34.	12.	11.	
S00110	04IL15C1	6.6	1.4	0.9	5.3	2.3	0.4	5.2	1.1	17.	13.	5.	
S00111	04IL16C1	6.4	1.4	0.9	5.3	2.6	0.5	6.9	1.3	18.	13.	12.	
S00159	04IL17L1	8.1	1.6	1.0	5.7	2.7	0.5	6.4	1.3	58.	12.	9.	
S00112	04IL17C1	7.7	1.6	1.1	5.8	2.8	0.5	7.3	1.2	24.	14.	8.	
S00113	04IL18C1	6.4	1.3	1.0	5.3	2.7	0.5	9.1	1.5	13.	14.	3.	
S00114	04IL19C1	7.3	1.3	1.0	5.5	2.8	0.5	7.0	1.2	20.	14.	3.	
S00160	04IL19L1	6.8	1.4	1.0	5.2	2.6	0.5	5.2	1.3	38.	12.	9.	
S00115	04IL20C1	7.7	1.6	1.6	5.4	2.6	0.5	7.4	1.3	46.	14.	10.	
S00116	04IL21C1	6.6	1.1	0.7	4.4	2.2	0.3	4.7	1.0	18.	10.	<4.	
S00117	04IL22C1	6.6	1.4	0.8	4.5	2.2	0.4	4.4	1.0	24.	11.	5.8	
S00118	04IL23C1	6.1	1.3	0.7	4.3	2.1	0.3	4.6	1.0	24.	11.	4.7	
S00119	04IL24C1	6.3	1.3	0.9	4.3	2.0	0.4	4.3	1.0	12.	11.	4.5	
S00120	04IL25C1	6.4	1.2	0.8	4.3	2.1	0.4	4.2	1.0	16.	11.	<4.	
S00121	04IL26C1	7.0	1.3	0.9	4.8	2.2	0.4	4.7	1.1	34.	12.	5.1	
S00161	04IL27L1	8.3	1.5	1.0	5.1	2.4	0.4	5.5	1.0	48.	11.	7.	
S00122	04IL27C1	7.0	1.4	0.9	4.2	1.6	0.2	2.7	0.4	9.0	5.7	7.	
S00123	04IL28C1	4.0	0.9	0.7	3.1	1.6	0.2	3.1	0.6	<6.6	7.4	<2.	
S00162	04IL29L1	3.0	0.5	0.3	1.9	0.9	0.2	3.9	0.4	30.	4.1	<3.	

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00124	04IL29C1	1.7	0.3	0.2	1.5	0.6	0.1	4.6	0.1	<7.8	2.1	<2.	
S00125	04IL30C1	2.0	0.4	0.3	1.5	0.6	0.09	0.8	0.2	<4.8	1.9	<2.	
S00172	05IL01L1	7.0	1.5	0.9	4.4	2.1	0.4	3.8	1.0	54.	11.	8.	
S00173	05IL01L2	7.9	1.5	0.7	5.2	2.1	0.4	3.7	0.9	40.	9.6	20.	
S00174	05IL01L3	6.8	1.4	0.8	5.2	2.1	0.4	4.2	0.9	42.	11.	20.	
S00073	06IL04C1	4.3	0.8	0.6	3.2	2.1	0.3	6.4	1.0	8.4	10.	<5.	
S00074	06IL05C1	4.9	0.9	0.9	4.0	2.0	0.3	5.2	1.5	8.8	14.	<5.	
S00075	06IL06C1	4.9	1.0	0.8	3.9	2.5	0.4	5.8	1.3	7.0	13.	<5.	
S00076	06IL07C1	5.4	1.0	0.9	4.4	2.1	0.3	8.6	1.2	15.	13.	<4.	
S00077	06IL08C1	5.4	1.0	0.6	3.9	1.9	0.3	4.0	1.1	10.	10.	<4.	
S00078	06IL09C1	6.0	1.1	0.7	4.2	2.1	0.4	5.0	1.3	9.0	12.	2.6	
S00079	06IL10C1	5.4	0.9	0.6	4.0	2.0	0.3	4.1	1.1	19.	10.	<6.	
S00080	06IL11C1	5.2	1.0	0.4	3.9	1.7	0.3	5.1	1.3	22.	13.	<3.	
S00163	06IL11L1	5.8	1.0	0.7	4.0	2.2	0.4	4.7	1.2	66.	10.	<2.	
S00081	06IL12C1	4.8	1.0	0.6	3.6	2.0	0.4	4.4	1.2	22.	11.	<4.	
S00082	06IL13C1	5.5	1.0	0.5	3.9	1.7	0.3	4.5	1.3	12.	12.	<4.	
S00164	06IL13L1	6.8	1.2	0.8	4.2	2.2	0.5	4.5	1.3	44.	13.	3.3	
S00165	06IL13L2	6.5	1.1	0.7	4.1	2.0	0.4	4.6	1.3	44.	14.	5.1	
S00166	06IL14L1	4.5	1.0	0.7	3.9	1.7	0.3	4.0	1.1	28.	12.	5.	
S00083	06IL14C1	4.9	0.8	0.5	3.6	1.8	0.3	3.7	1.1	16.	10.	<5.	
S00084	06IL15C1	5.8	1.0	0.6	3.7	1.6	0.3	4.4	1.1	18.	13.	6.	
S00085	06IL16C1	5.5	0.9	0.5	3.7	1.4	0.3	4.4	1.1	24.	12.	<3.	
S00086	06IL17C1	5.3	1.0	0.7	4.0	2.1	0.3	4.0	1.0	34.	10.	9.	
S00087	06IL18C1	7.4	0.9	0.7	3.6	1.4	0.3	3.6	1.1	26.	11.	14.	
S00088	06IL19C1	5.7	1.2	1.3	4.2	2.6	0.4	4.3	0.9	30.	11.	31.	
S00167	06IL19L1	7.5	1.4	0.8	4.5	2.2	0.4	4.0	0.9	67.	10.	51.	
S00089	06IL20C1	5.8	1.5	1.0	5.6	2.5	0.5	5.1	1.0	42.	10.	54.	
S00168	06IL21L1	7.6	1.7	0.8	5.9	2.3	0.4	4.9	0.9	52.	10.	19.	
S00090	06IL21C1	6.6	1.4	1.1	5.0	2.9	0.5	4.7	1.1	30.	11.	17.	
S00169	06IL22L1	6.4	1.4	0.8	5.2	2.3	0.4	4.4	1.1	47.	12.	11.	
S00091	06IL22C1	7.2	1.4	1.1	4.6	3.1	0.6	4.9	1.1	20.	12.	8.6	
S00092	06IL23C1	5.9	1.2	0.8	4.0	2.3	0.4	3.7	0.9	34.	10.	8.7	
S00093	06IL24C1	5.9	1.2	1.0	4.9	2.6	0.5	8.1	1.0	14.	10.	4.1	
S00170	06IL25L1	5.7	1.2	0.9	4.5	2.0	0.4	5.4	0.9	42.	10.	<4.	
S00094	06IL25C1	5.7	1.3	0.9	4.3	2.5	0.5	5.6	1.1	56.	12.	4.7	
S00171	06IL25L2	5.2	1.1	0.6	3.6	1.3	0.2	2.4	0.4	84.	5.4	2.	
S00126	07IL01L1	2.2	0.4	0.2	1.6	0.7	0.1	0.5	0.1	<4.8	1.	<2.	
S00127	07IL01L2	6.0	1.0	0.5	4.1	2.3	0.4	3.9	1.3	42.	12.	16.	
S00128	07IL01L3	7.1	1.1	0.7	4.1	2.3	0.4	3.4	1.0	13.	9.6	<4.	
S00129	07IL02L1	5.7	1.0	0.7	4.7	2.5	0.5	5.7	1.3	12.	11.	<4.	
S00130	07IL02L2	10.	1.8	1.2	6.5	2.5	0.4	2.4	0.6	42.	5.1	<4.	
S00131	07IL03L1	7.4	1.1	0.7	5.0	2.8	0.5	5.7	1.3	16.	11.	<7.	
S00132	07IL04L1	9.6	1.5	0.9	5.8	2.8	0.5	4.4	1.2	36.	11.	31.	
S00133	07IL04L2	7.5	1.4	0.8	5.2	2.6	0.5	4.2	1.0	30.	10.	22.	
S00134	07IL05L1	1.4	0.3	0.2	1.2	0.4	0.09	0.9	0.07	6.4	0.8	<2.	
S00135	09IL01L3	6.1	1.1	0.7	4.4	2.3	0.5	3.2	0.9	100.	8.8	21.	
S00323	10IL01L1	6.7	1.4	0.9	4.8	2.3	0.4	3.7	1.1	52.	10.	27.	
S00324	10IL01L2	5.8	1.2	0.9	4.9	2.3	0.5	4.9	1.1	30.	11.	19.	
S00325	10IL01L3	6.0	1.2	0.7	3.5	1.5	0.3	4.1	0.5	9.8	5.0	<6.	

Table CI. Continued.

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00326	10IL01L4	5.0	1.0	0.5	3.6	1.3	0.2	1.2	0.4	7.4	3.9	<5.	
S00327	10IL01L5	4.0	0.9	0.6	3.1	0.9	0.2	1.1	0.1	3.1	1.9	<6.	
S00328	10IL01L6	3.6	0.7	0.6	3.0	1.3	0.3	3.0	0.5	14.	5.7	<6.	
S00329	10IL01L7	1.6	0.4	0.2	1.1	0.4	<0.1	2.0	<0.1	1.4	0.8	<5.	
S00330	11IL02C1	8.4	1.9	1.5	8.8	4.9	0.7	4.1	1.1	93.	14.	44.	5.
S00331	11IL03C1	7.0	1.5	1.1	6.0	2.5	0.4	3.6	1.1	73.	12.	26.	6.
S00377	11IL04L1	7.1	1.8	0.9	6.9	3.5	0.8	4.4	1.6	42.	30.	14.	9.
S00378	11IL04L*	30.	7.7	2.6	15.	6.4	0.9	6.7	12.	38.	61.	25.	39.
S00332	11IL04C1	11.	1.8	1.0	7.1	3.0	0.5	3.8	1.2	72.	19.	48.	12.
S00333	11IL05C1	6.8	1.2	1.0	5.6	2.6	0.5	4.2	1.2	27.	15.	<5.	4.
S00334	11IL06C1	6.9	1.4	0.8	6.4	2.8	0.5	4.7	1.0	47.	12.	8.	5.
S00335	11IL07C2	9.2	1.8	1.3	6.4	3.0	0.5	4.9	1.3	30.	20.	8.	6.
S00336	11IL08C1	7.2	1.4	1.2	6.1	3.0	0.5	5.7	1.2	24.	15.	6.	5.
S00337	11IL09C1	9.8	1.9	1.3	8.2	5.2	0.8	7.0	1.0	37.	62.	10.	8.
S00338	11IL10C1	6.1	1.2	0.7	5.7	3.6	0.7	6.4	1.2	38.	25.	<6.	8.
S00379	11IL10L1	5.4	1.2	0.8	3.9	2.3	0.4	4.1	0.9	29.	9.6	<5.	6.
S00339	11IL11C1	6.1	1.2	0.8	4.8	2.6	0.5	5.0	1.1	43.	11.	12.	7.
S00380	11IL11L1	6.4	1.3	0.8	6.9	3.6	0.6	7.0	1.1	28.	22.	<7.	8.
S00340	11IL12C1	6.7	1.3	1.0	7.5	3.9	0.7	4.8	1.1	67.	44.	10.	7.
S00381	11IL12L1	7.5	1.4	1.4	11.	6.2	1.1	4.5	1.0	29.	37.	<11.	8.
S00341	11IL13C1	6.9	1.5	0.9	6.2	2.9	0.5	4.0	1.0	70.	17.	37.	11.
S00342	11IL14C1	7.3	1.6	0.9	5.6	2.7	0.6	3.7	1.0	45.	12.	15.	4.
S00343	11IL15C1	8.3	1.8	1.0	6.1	2.8	0.5	3.7	1.0	42.	11.	37.	5.
S00344	11IL16C1	6.2	1.0	0.3	1.6	1.2	0.2	3.1	0.7	46.	18.	<5.	6.
S00345	11IL17C1	7.4	1.5	1.1	5.3	2.7	0.5	3.9	1.1	42.	12.	12.	5.
S00346	11IL17C2	5.1	1.1	0.8	5.5	2.5	0.5	3.6	0.8	97.	12.	10.	5.
S00347	11IL18C1	6.6	1.4	0.9	5.2	2.5	0.5	4.1	1.0	35.	11.	<5.	6.
S00348	11IL19C1	5.6	1.0	0.3	3.3	1.7	0.4	4.0	0.8	19.	15.	<6.	5.
S00349	11IL20C1	4.1	0.9	0.7	6.0	3.3	0.7	3.2	0.7	87.	21.	<5.	4.
S00350	11IL21C1	5.3	1.1	0.7	4.0	2.3	0.6	5.3	1.0	30.	11.	5.	6.
S00402	12IL01C1	8.2	1.7	0.9	6.3	2.8	0.6	3.9	1.0	120.	10.	24.	
S00403	12IL01C2	6.8	1.3	0.9	5.1	3.0	0.6	4.8	1.2	41.	11.	15.	
S00404	12IL01C3	5.8	1.2	0.7	4.8	2.3	0.5	3.4	1.0	22.	8.8	17.	
S00405	12IL01C4	6.3	1.2	0.6	5.4	2.7	0.5	4.5	1.1	21.	10.	15.	
S00407	13IL04C1	8.8	1.6	1.0	5.6	2.6	0.4	3.8	1.0	26.	9.8	<5.	
S00408	13IL05C1	5.4	1.1	0.6	4.8	2.5	0.5	5.3	1.1	51.	12.	10.	
S00409	13IL06C2	7.2	1.4	0.9	5.6	2.8	0.5	5.1	1.2	16.	11.	17.	
S00410	13IL07C2	5.9	1.2	0.8	5.1	2.5	0.6	3.5	1.0	8.6	7.7	22.	
S00411	13IL08C1	6.8	1.4	1.0	5.8	2.6	0.6	4.7	1.2	16.	9.5	32.	
S00412	13IL09C1	6.4	1.5	0.9	5.4	2.4	0.5	3.5	1.0	22.	9.7	44.	
S00413	13IL10C1	5.8	1.2	1.0	4.5	2.2	0.4	3.0	0.9	9.8	8.1	51.	
S00414	13IL11C2	6.7	1.5	0.8	5.4	2.3	0.4	4.7	1.0	46.	9.7	48.	
S00415	13IL12C3	7.3	1.5	1.0	5.1	2.4	0.5	4.1	1.1	37.	10.	30.	
S00416	13IL13C2	6.1	1.3	0.9	4.8	1.9	0.4	3.6	0.8	25.	8.5	24.	
S00417	13IL14C3	7.6	1.6	0.9	5.5	2.5	0.6	4.0	1.1	66.	10.	41.	
S00418	13IL15C2	7.9	1.7	1.2	5.6	2.6	0.5	4.6	1.1	48.	11.	37.	
S00419	13IL16C2	7.5	1.7	0.8	6.0	2.5	0.4	3.5	1.0	59.	10.	33.	
S00420	13IL17C4	7.1	1.5	0.9	6.4	2.6	0.4	4.3	1.0	64.	9.7	16.	
S00421	13IL18C2	7.9	1.6	1.0	5.3	2.7	0.5	5.2	1.1	64.	12.	15.	

* Sample 11IL04L* is a dike in 11IL04L1.

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00422	13IL19C1	8.0	1.7	0.9	5.4	2.6	0.4	5.1	1.1	46.	12.	11.	
S00423	13IL20C1	7.3	1.4	0.9	5.1	2.4	0.5	4.7	1.2	23.	11.	12.	
S00424	13IL21C2	7.9	1.7	1.2	6.0	2.8	0.6	5.0	1.1	38.	11.	21.	
S00425	13IL22C2	7.6	1.5	0.9	5.4	2.5	0.5	4.3	1.1	33.	12.	13.	
S00426	13IL23C4	6.0	1.2	0.5	3.9	1.9	0.3	3.0	0.7	47.	8.6	8.	
S00427	13IL24C2	5.1	1.1	0.5	3.6	2.1	0.4	2.6	0.6	28.	6.9	<6.	
S00428	13IL25C3	4.7	1.1	0.6	3.5	1.5	0.2	1.8	0.5	15.	4.4	10.	
S00429	13IL26C3	5.4	1.1	0.7	4.0	1.7	0.3	2.5	0.6	12.	5.2	7.	
S00430	13IL27C1	5.4	1.2	0.9	4.6	2.2	0.4	2.3	0.6	14.	5.7	9.	
S00352	01IN01C1	8.7	1.8	1.6	7.0	3.7	0.5	4.4	1.1	96.	9.5	32.	
S00353	01IN01C2	6.9	1.4	1.0	5.6	2.6	0.5	3.8	1.0	55.	8.3	20.	
S00354	01IN02C1	6.8	1.4	0.8	5.3	2.2	0.4	3.7	0.9	30.	8.5	22.	
S00355	01IN03C1	5.7	1.2	0.8	4.0	1.8	0.4	3.1	0.8	28.	8.1	29.	
S00356	01IN03C2	6.6	1.4	0.7	4.7	2.1	0.4	3.4	1.0	25.	9.7	35.	
S00357	01IN03C3	7.2	1.6	1.1	5.9	2.6	0.4	3.8	1.1	22.	9.4	46.	
S00358	01IN04C1	8.1	1.8	1.2	6.4	2.5	0.4	3.5	1.0	19.	8.5	63.	
S00359	01IN04C2	7.6	1.5	1.0	5.5	2.4	0.4	4.3	1.0	20.	8.6	54.	
S00360	01IN05C1	7.4	1.6	1.0	5.4	2.4	0.4	4.8	1.3	67.	11.	26.	
S00361	01IN05C2	7.3	1.5	1.0	5.5	2.5	0.5	4.5	1.1	51.	11.	21.	
S00362	01IN05C3	7.2	1.6	0.9	5.9	2.6	0.5	4.9	1.3	55.	12.	22.	
S00363	01IN07C1	6.6	1.3	0.8	5.9	2.2	0.4	3.7	1.1	48.	10.	12.	
S00364	01IN07C2	6.7	1.4	1.0	4.9	2.2	0.5	3.8	1.2	39.	11.	14.	
S00365	01IN08C1	6.8	1.5	0.8	5.0	2.4	0.4	3.5	1.0	66.	10.	19.	
S00366	01IN08C2	6.8	1.4	1.1	4.7	2.3	0.4	3.4	1.0	66.	9.9	23.	
S00367	01IN09C1	7.4	1.6	1.1	5.8	2.7	0.4	3.7	1.0	64.	11.	45.	
S00368	01IN09C2	7.4	1.5	0.9	5.7	3.0	0.5	5.6	1.5	25.	13.	8.	
S00369	01IN10C1	3.8	0.8	0.6	3.3	1.3	0.2	1.5	0.4	4.3	3.8	5.	
S00370	01IN10C2	7.1	1.5	0.7	5.0	2.3	0.6	4.3	1.1	48.	11.	13.	
S00371	01IN10C3	7.4	1.6	0.8	5.2	2.6	0.4	4.0	1.0	52.	11.	35.	
S00372	01IN11C1	8.5	1.8	1.2	6.4	2.6	0.5	3.6	0.9	78.	10.	41.	
S00373	01IN11C2	7.2	1.5	0.9	5.2	2.9	0.4	4.0	0.9	40.	11.	11.	
S00374	01IN11C3	6.8	1.5	0.9	4.4	2.2	0.5	3.1	0.8	43.	8.5	13.	
S00375	01IN13C1	6.9	1.4	0.9	4.8	2.1	0.4	3.4	0.8	44.	8.5	10.	
S00376	01IN13C2	6.5	1.4	1.0	4.5	2.0	0.3	2.5	0.6	32.	6.5	14.	
S00049	71477A	6.0	1.2	0.9	4.7	2.6	0.5	5.4	1.4		11.	25.	
S00050	71477B	6.2	1.3	0.8	5.3	2.7	0.6	5.8	1.5		12.	20.	
S00136	NAS-0021	6.5	1.2	0.7	4.9	2.4	0.3	2.6	0.7	56.	9.0	44.	
S00137	NAS-0025	7.0	1.4	0.8	5.3	2.4	0.4	2.9	0.8	26.	7.5	48.	
S00138	NAS-0028	7.6	1.3	0.7	4.8	2.5	0.4	3.5	1.1	32.	9.7	30.	
S00139	NAS-0031	6.9	1.2	0.9	4.6	2.4	0.4	4.0	0.9	68.	9.0	12.	
S00140	NAS-0032	7.2	1.6	0.8	5.3	2.2	0.5	3.8	1.1	42.	11.	19.	
S00141	NAS-0033	6.2	1.4	0.7	4.5	2.2	0.5	3.0	0.9	36.	9.0	31.	
S00142	NAS-0036	5.5	1.1	0.7	4.2	1.9	0.4	4.0	1.0	250.	9.0	<7.	
S00143	NAS-0037	6.0	1.3	0.7	4.1	2.0	0.4	4.1	1.1	42.	11.	<7.	
S00144	NAS-0041	6.3	1.2	0.7	4.0	2.3	0.4	5.8	1.6	15.	13.	<4.	
S00145	NAS-0043	6.4	1.3	0.7	4.2	2.0	0.4	3.8	1.1	26.	11.	19.	
S00146	NAS-0045	6.5	1.4	0.8	5.2	2.3	0.5	4.5	1.1	26.	9.2	19.	
S00147	NAS-0046	5.4	1.2	0.6	4.3	1.9	0.3	2.8	0.8	17.	8.1	31.	
S00148	NAS-0050	5.9	1.5	0.9	4.6	2.6	0.5	3.6	1.1	40.	10.	41.	

Table C1. Continued.

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00149	NAS-0054	6.4	1.4	0.8	4.4	2.3	0.5	3.9	1.0	66.	9.3	38.	
S00150	NAS-0057	6.6	1.4	0.9	5.1	2.8	0.5	3.8	1.0	58.	9.8	22.	
S00151	NAS-0059	6.8	1.5	0.8	4.9	2.2	0.4	3.2	1.0	100.	9.7	33.	
S00152	NAS-0061	6.1	1.3	0.9	4.9	2.5	0.4	3.7	0.9	65.	9.4	23.	
S00153	NAS-0062	6.5	1.4	0.7	4.6	2.3	0.4	4.6	1.1	66.	11.	12.	
S00154	NAS-0065	8.9	1.7	1.1	6.0	2.8	0.5	4.0	1.0	46.	9.8	21.	
S00155	NAS-0067	7.3	1.4	0.9	5.1	2.2	0.5	3.1	0.8	62.	8.8	39.	
S00156	NAS-0068	5.9	1.1	0.8	4.1	1.7	0.3	2.2	0.5	34.	5.6	13.	
S00157	NAS-0070	8.5	1.5	1.0	6.3	2.8	0.6	4.5	1.1	36.	10.	15.	
S00158	NAS-0072	7.9	1.5	0.9	6.1	2.6	0.5	4.6	1.1	36.	11.	20.	
S00175	NAS-0084	5.1	1.2	0.7	4.7	2.2	0.4	5.2	1.2	38.	12.	10.	
S00176	NAS-0087	6.2	1.2	0.6	4.9	1.9	0.4	3.9	0.9	49.	9.4	36.	
S00177	NAS-0090	6.7	1.4	0.8	5.6	2.0	0.3	2.9	0.8	38.	7.5	38.	
S00178	NAS-0091	6.0	1.2	0.8	5.0	1.9	0.3	3.0	0.7		8.1	23.	
S00179	NAS-0092	6.2	1.3	0.8	4.9	1.9	0.4	3.3	0.8		8.8	11.	
S00180	NAS-0093	6.3	1.2	0.8	5.0	2.4	0.4	3.2	0.8		7.6	33.	
S00181	NAS-0094	6.3	1.4	1.1	5.7	2.3	0.5	3.2	0.9		9.5	32.	
S00182	NAS-0095	6.6	1.5	0.9	5.8	2.5	0.5	3.4	0.9		9.4	31.	
S00183	NAS-0096	5.6	1.2	1.0	4.6	2.1	0.5	2.3	0.6		6.9	11.	
S00184	NAS-0102	7.5	1.5	0.9	5.8	2.5	0.7	4.4	1.0		10.	46.	
S00185	NAS-0103	6.6	1.3	0.8	5.4	2.4	0.5	3.1	0.8		8.2	41.	
S00186	NAS-0104	6.5	1.4	0.8	4.9	2.2	0.5	3.5	0.8		10.	11.	
S00187	NAS-0106	6.5	1.2	0.7	5.3	2.5	0.5	5.9	1.4		13.	<4.	
S00188	NAS-0107	7.1	1.4	1.0	5.2	2.4	0.6	4.0	0.9		9.0	58.	
S00189	NAS-0110	8.3	1.5	1.0	5.2	2.4	0.5	5.0	1.2		11.	33.	
S00190	NAS-0112	7.3	1.2	0.7	5.0	2.3	0.5	5.1	1.0		10.	7.	
S00191	NAS-0114	9.8	1.9	1.5	6.9	3.4	0.7	3.5	0.7		7.6	26.	
S00192	NAS-0115	7.0	1.5	0.9	5.3	2.4	0.7	4.0	0.9		9.6	31.	
S00193	NAS-0116	7.4	1.3	0.7	4.9	2.1	0.4	4.5	0.9		9.8	19.	
S00194	NAS-0117	6.8	1.3	0.8	5.0	2.1	0.4	2.5	0.6		6.4	9.	
S00195	NAS-0119	7.3	1.4	0.8	5.5	2.2	0.5	3.3	0.8		7.6	32.	
S00196	NAS-0120	7.1	1.3	0.7	4.7	2.1	0.3	3.6	0.8		8.3	16.	
S00197	NAS-0121	6.9	1.3	0.7	4.8	2.2	0.5	3.5	0.8		8.0	21.	
S00198	NAS-0123	9.9	1.7	1.1	6.4	2.9	0.5	4.2	1.0		10.	9.	
S00199	NAS-0124	7.2	1.4	0.8	5.1	2.0	0.4	3.2	0.8		7.7	28.	
S00200	NAS-0125	7.0	1.4	0.9	5.3	2.5	0.5	5.1	1.2		12.	14.	
S00201	NAS-0126	6.3	1.4	0.7	5.3	2.0	0.4	2.4	0.6		6.1	13.	
S00202	NAS-0129	6.1	1.3	0.8	5.1	2.2	0.3	3.5	0.8		7.8	37.	
S00203	NAS-0130	7.3	1.4	1.0	5.2	2.1	0.4	3.7	0.9		8.7	27.	
S00204	NAS-0131	5.7	1.3	0.8	4.3	1.8	0.4	2.3	0.5		6.2	10.	
S00205	NAS-0134	5.8	1.2	0.8	4.3	2.4	0.4	4.1	0.9		10.	<5.	
S00206	NAS-0135	6.5	1.4	0.8	5.3	2.4	0.5	4.1	1.1		12.	11.	
S00207	NAS-0138	6.6	1.4	0.8	5.2	2.2	0.5	3.8	0.9		11.	13.	
S00208	NAS-0141	6.2	1.3	0.9	5.0	2.2	0.5	3.7	1.0	68.	11.	30.	
S00209	NAS-0144	5.8	1.3	0.7	4.2	2.1	0.5	2.7	0.8	70.	8.2	34.	
S00210	NAS-0145	4.4	1.2	0.7	4.8	2.1	0.4	3.9	0.9		9.7	15.	
S00211	NAS-0148	7.0	1.5	0.9	5.5	2.3	0.5	3.4	0.8	72.	9.3	34.	
S00212	NAS-0151	6.7	1.3	0.8	4.9	2.5	0.5	4.1	1.1	140.	11.	39.	
S00213	NAS-0153	6.5	1.2	0.7	4.6	2.3	0.5	4.2	1.2	63.	12.	35.	

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00214	NAS-0156	6.5	1.5	0.9	5.0	2.4	0.4	3.6	1.0	68.	8.3	43.	
S00215	NAS-0159	8.3	1.5	0.9	6.0	2.8	0.5	4.3	0.9		8.9	23.	
S00216	NAS-0161	6.5	1.6	0.9	5.3	2.6	0.5	4.6	1.1		11.	29.	
S00217	NAS-0162	7.7	1.6	0.9	4.5	2.4	0.5	3.9	0.9		9.5	22.	
S00218	NAS-0165	6.6	1.6	0.8	5.5	2.5	0.4	4.4	1.0		11.	23.	
S00219	NAS-0166	7.1	1.4	0.9	5.5	2.7	0.5	4.2	1.0		9.0	17.	
S00220	NAS-0167	6.1	1.4	0.8	5.1	2.3	0.4	4.3	1.1		11.	18.	
S00221	NAS-0170	7.3	1.5	0.8	5.0	2.4	0.6	4.2	1.0		9.3	40.	
S00222	NAS-0174	7.8	1.6	1.0	4.8	2.5	0.4	5.5	1.2		12.	32.	
S00223	NAS-0176	7.4	1.5	0.9	5.0	2.3	0.5	4.4	1.0		8.9	37.	
S00224	NAS-0177	7.7	1.6	0.9	5.0	2.5	0.5	4.9	1.1		11.	26.	
S00225	NAS-0181	7.8	1.6	0.9	5.4	2.5	0.4	4.7	1.2		11.	32.	
S00226	NAS-0183	6.8	1.4	0.9	4.7	2.4	0.5	3.9	1.0		8.7	35.	
S00227	NAS-0185	8.1	1.7	1.0	5.3	2.6	0.5	5.1	1.1		11.	19.	
S00228	NAS-0189	7.4	1.5	1.0	5.5	2.4	0.5	3.5	1.0	63.	8.8	45.	
S00229	NAS-0192	7.6	1.5	0.8	5.4	2.1	0.4	3.2	0.9		8.5	29.	
S00230	NAS-0193	6.1	1.2	0.7	4.0	1.6	0.3	1.9	0.5		5.0	9.	
S00231	NAS-0195	6.1	1.3	0.6	4.5	2.3	0.4	3.9	1.2		12.	17.	
S00232	NAS-0196	5.9	1.4	0.7	4.7	2.0	0.4	3.5	1.0		10.	25.	
S00233	NAS-0198	7.2	1.4	0.7	5.4	2.4	0.4	4.1	1.1		10.	20.	
S00234	NAS-0202	8.0	1.5	0.9	5.0	2.4	0.4	3.8	1.1		11.	21.	
S00235	NAS-0206	6.9	1.5	1.0	5.1	2.4	0.4	3.3	1.0		8.1	42.	
S00236	NAS-0207	6.0	1.4	0.7	4.3	2.2	0.4	3.1	0.9	93.	8.6	27.	
S00237	NAS-0208	6.7	1.7	1.0	5.5	2.6	0.5	3.5	1.0	72.	10.	27.	
S00238	NAS-0212	7.5	1.6	0.9	6.0	2.5	0.5	3.4	1.0		11.	45.	
S00239	NAS-0213	7.0	1.5	0.9	5.9	2.8	0.5	3.6	1.1	33.	9.9	21.	
S00240	NAS-0214	7.1	1.7	1.0	5.7	2.6	0.5	3.6	1.1	48.	11.	27.	
S00241	NAS-0215	6.4	1.3	0.7	3.8	1.8	0.3	2.4	0.6		6.5	12.	
S00242	NAS-0216	6.8	1.4	0.9	4.3	2.2	0.5	3.9	1.2	61.	11.	24.	
S00243	NAS-0219	6.6	1.4	0.8	4.3	2.4	0.5	4.1	1.1	45.	11.	26.	
S00244	NAS-0222	6.6	1.3	0.8	5.2	2.8	0.5	7.0	1.6	7.5	14.	<6.	
S00245	NAS-0224	7.2	1.5	0.8	4.9	2.5	0.5	5.0	1.2	27.	12.	17.	
S00246	NAS-0227	6.3	1.4	0.7	4.9	2.2	0.4	3.6	1.0	71.	10.	26.	
S00247	NAS-0229	6.6	1.4	0.8	4.8	2.2	0.6	3.9	1.1	45.	11.	24.	
S00248	NAS-0233	8.4	1.8	1.0	5.6	2.3	0.5	4.2	1.2	37.	12.	18.	
S00249	NAS-0234	6.8	1.3	0.7	4.4	2.4	0.5	4.1	1.1	60.	12.	24.	
S00250	NAS-0237	6.8	1.4	0.8	5.1	2.3	0.4	4.5	1.1	29.	11.	9.	
S00251	NAS-0240	6.8	1.3	0.8	4.5	2.0	0.5	4.0	1.0	41.	11.	28.	
S00252	NAS-0242	6.2	1.3	0.7	4.9	2.0	0.4	3.9	1.1	32.	11.	21.	
S00253	NAS-0246	5.9	1.5	1.1	4.9	2.5	0.6	3.6	1.0	18.	9.2	40.	
S00254	NAS-0247	5.5	1.3	0.8	4.8	2.0	0.6	2.8	0.7	36.	7.9	33.	
S00255	NAS-0249	5.7	1.2	0.6	4.3	2.1	0.4	3.0	0.8	62.	6.8	9.	
S00256	NAS-0252	7.0	1.6	0.9	5.4	2.5	0.6	4.6	1.2	56.	12.	35.	
S00257	NAS-0253	6.6	1.4	0.8	5.0	2.5	0.6	3.9	0.8	37.	9.4	14.	
S00269	NAS-0292	5.6	1.3	0.7	4.6	2.1	0.5	3.1	0.8	24.	9.1	40.	
S00270	NAS-0295	7.4	1.6	0.9	5.8	2.8	0.6	4.9	1.2	220.	11.	24.	
S00271	NAS-0298	7.6	1.6	0.9	5.6	2.4	0.4	4.5	1.4	29.	13.	30.	
S00272	NAS-0300	7.6	1.5	0.9	5.1	2.5	0.4	4.5	1.2	30.	11.	32.	
S00273	NAS-0307	7.4	1.5	0.9	5.4	2.4	0.4	3.6	1.1	37.	9.3	21.	

Table C1. Continued.

Sample no.	Geol. no.	Sm (ppm)	Eu (ppm)	Tb (ppm)	Dy (ppm)	Yb (ppm)	Lu (ppm)	Hf (ppm)	Ta (ppm)	Pb (ppm)	Th (ppm)	U (ppm)	W (ppm)
S00274	NAS-0309	7.7	1.4	0.9	5.1	2.4	0.7	4.0	1.2	36.	10.	30.	
S00275	NAS-0314	6.6	1.4	0.6	4.7	2.3	0.4	4.1	1.2	34.	10.	31.	
S00276	NAS-0317	8.2	1.6	0.9	5.9	2.5	0.6	4.9	1.1	30.	12.	27.	
S00277	NAS-0320	7.2	1.4	0.7	5.3	2.2	0.4	3.6	1.0	36.	9.7	40.	
S00278	NAS-0322	7.0	1.4	0.9	5.4	2.2	0.5	4.8	1.1	49.	9.3	26.	
S00279	NAS-0325	6.1	1.3	1.0	4.9	2.4	0.5	4.6	1.2	55.	9.3	23.	
S00280	NAS-0331	8.0	1.5	1.0	4.7	2.4	0.5	4.1	1.1	72.	10.	26.	
S00281	NAS-0335	7.2	1.6	1.0	5.4	2.5	0.6	3.7	1.1	46.	9.3	40.	
S00282	NAS-0338	8.4	1.6	1.0	5.2	2.6	0.5	4.0	1.2	38.	10.	27.	
S00283	NAS-0343	6.2	1.2	0.8	4.3	2.2	0.5	3.0	0.9	30.	8.4	29.	
S00284	NAS-0346	7.4	1.5	1.0	5.0	2.5	0.7	3.6	1.1	39.	9.5	29.	
S00285	NAS-0348	6.0	1.3	0.7	4.6	2.2	0.5	3.0	0.8	23.	8.3	41.	
S00286	NAS-0351	6.1	1.3	0.8	4.8	2.2	0.6	3.3	1.0	23.	9.0	37.	
S00287	NAS-0355	6.8	1.4	0.8	5.6	2.4	0.6	3.4	1.0	32.	8.4	32.	
S00288	NAS-0359	6.4	1.4	1.1	5.2	2.3	0.5	3.4	1.0	31.	8.9	41.	
S00289	NAS-0360	8.3	1.6	0.9	5.6	2.7	0.7	4.6	1.2	54.	11.	29.	
S00290	NAS-0361	7.5	1.5	0.8	5.1	2.4	0.4	4.3	1.2	36.	12.	11.	
S00291	NAS-0366	8.1	1.5	1.0	5.1	2.4	0.5	4.7	1.2	27.	11.	27.	
S00292	NAS-0369	6.9	1.4	1.0	5.0	2.4	0.4	3.7	0.9	30.	9.0	34.	
S00293	NAS-0370	6.5	1.5	0.9	5.2	2.1	0.4	3.5	0.9	33.	8.9	46.	
S00294	NAS-0377	6.4	1.3	0.9	4.6	2.2	0.4	4.1	0.9	23.	9.4	24.	
S00295	NAS-0380	7.3	1.5	1.0	5.1	2.7	0.5	5.7	1.3	22.	12.	20.	
S00296	NAS-0383	7.0	1.5	0.9	5.6	2.5	0.6	3.9	1.2	26.	10.	41.	
S00297	NAS-0389	8.4	1.6	0.9	5.5	2.4	0.5	4.2	1.1	22.	12.	26.	
S00298	NAS-0393	7.3	1.5	0.8	5.3	2.4	0.6	4.0	1.0	39.	10.	33.	
S00299	NAS-0396	6.5	1.4	0.8	5.0	2.3	0.5	4.0	1.0	55.	9.3	15.	
S00300	NAS-0398	5.3	1.2	0.9	4.5	2.0	0.4	2.7	0.8		7.1	42.	
S00301	NAS-0402	8.2	1.6	1.0	5.8	2.4	0.5	6.1	1.3	33.	12.	8.	
S00302	NAS-0409	6.7	1.3	0.8	5.1	2.4	0.5	3.9	1.1	56.	10.	32.	
S00303	NAS-0413	6.3	1.2	0.8	4.1	2.1	0.4	4.0	1.2	48.	11.	16.	
S00304	NAS-0415	6.5	1.3	0.7	5.1	2.2	0.3	3.5	1.1	32.	9.9	35.	
S00305	NAS-0417	7.8	1.5	1.0	5.4	2.7	0.5	4.8	1.3	39.	12.	33.	
S00306	NAS-0421	7.3	1.4	0.9	5.4	2.4	0.5	3.4	1.0	20.	8.7	39.	
S00307	NAS-0424	7.7	1.6	0.9	5.8	2.5	0.4	4.0	1.1	37.	11.	21.	
S00308	NAS-0427	7.5	1.5	1.0	5.4	2.7	0.5	3.8	0.9	22.	8.9	29.	
S00309	NAS-0431	7.1	1.4	0.7	5.0	2.1	0.5	3.4	0.8	140.	8.8	23.	
S00310	NAS-0434	6.2	1.3	0.9	5.1	1.9	0.3	2.9	0.8	64.	8.0	50.	
S00311	NAS-0438	4.5	1.1	0.6	3.7	1.6	0.4	2.5	0.6		6.3	15.	
S00312	NAS-0444	7.8	1.6	0.8	5.5	2.3	0.4	3.8	1.0	33.	11.	15.	
S00313	NAS-0447	6.3	1.2	0.6	4.7	2.1	0.4	3.2	0.8	31.	8.4	23.	
S00314	NAS-0451	7.0	1.4	1.0	5.4	2.1	0.4	3.5	0.8	35.	9.8	15.	
S00315	NAS-0454	7.3	1.5	1.1	5.2	2.4	0.5	4.2	1.2	31.	11.	9.	
S00316	NAS-0459	7.0	1.5	0.8	5.2	2.2	0.4	4.2	1.0	28.	9.4	28.	
S00317	NAS-0460	7.2	1.6	1.0	5.6	2.5	0.6	4.5	1.1	69.	12.	12.	
S00318	NAS-0464	6.6	1.4	0.8	5.1	2.2	0.5	4.5	1.1	24.	11.	17.	
S00319	NAS-0466	7.0	1.4	1.0	5.3	2.4	0.5	4.8	1.2	21.	11.	20.	
S00320	NAS-0470	6.8	1.5	0.8	5.4	2.5	0.5	5.7	1.3	44.	12.	12.	
S00321	NAS-0473	6.5	1.5	1.0	5.0	2.3	0.5	3.5	0.9	45.	9.0	26.	
S00322	NAS-0476	4.6	1.2	0.7	4.3	1.6	0.3	2.1	0.5	22.	4.9	7.	