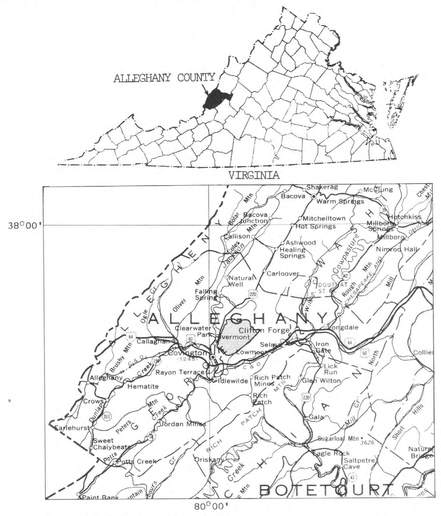
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1358-B



Base from U.S. Geological Survey
Virginia State map, 1973, 1:500,000

0 5 10 MILES
0 5 10 15 KILOMETERS

Figure 1.—Index map showing location of Dolly Ann Roadless Area.

Table 1.--*Analyses of iron-rich rock samples*

[Aluminum, iron, phosphorus, and some zinc analyses by inductively-induced plasma (ICP) methods using aqua regia digestion by A. L. Meier and J. M. Motooka, U.S. Geological Survey (USGS) laboratories, Denver, Colo.; most zinc analyses by atomic-absorption methods by B. F. Arbogast and J. D. Sharkey, USGS laboratories, Denver, Colo.; uranium by spectrofluorometric methods by J. D. Mensik, Geoco, Inc., Wheat Ridge, Colo.; and other elements analyzed for by semiquantitative optical-emission spectrographic methods by Shannon Gore, Specomp Services, Inc., Hayden, Colo. Spectrographic analyses are reported as six steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, 0.15, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. Symbols used: N, not detected; --, not determined; L, amount detected is below the lower limit of determination, which is number shown in parentheses below element symbol in column heading; <, less than number shown.]

Sample No.	Al	Fe	P	Co (5)	Cu (5)	Ni (5)	Mn (10)	Pb (10)	Zn	U	Sample description
	Percent			Parts per million							
				ROSE HILL FORMATION							
VDA 002	0.64	16.1	0.59	10	L	15	70	N	20	<1	2-m chip sample, hematitic sandstone. Specific gravity (sp gr) 2.82.
VDA 005	0.42	21.4	0.67	5	L	15	70	N	15	<1	1-m chip sample, hematitic sandstone, sp gr 3.0.
VDA 006	0.50	13.4	0.55	N	15	7	500	N	10	<1	2-m chip sample, hematitic sandstone, sp gr 2.67.
VDA 008	0.76	14.9	0.32	15	5	50	70	N	35	<1	1-m chip sample, hematitic sandstone, sp gr 2.90.
VDA 014	0.65	28.1	0.92	5	L	20	70	N	20	4	2-m chip sample, hematitic sandstone, sp gr 3.09.
VDA 015	0.65	28.2	0.68	10	15	30	100	N	20	1	1-m chip sample, hematitic sandstone, sp gr 3.13.
VDA 016	0.27	20.4	0.36	N	L	5	70	N	5	<1	1-m chip sample, hematitic sandstone, sp gr 2.94.
VDA 017	0.56	28.0	0.64	5	5	20	70	N	10	<1	2-m chip sample, hematitic sandstone, sp gr 3.33.
VDA 018	0.32	19.5	0.40	N	L	7	70	N	5	<1	1-m chip sample, hematitic sandstone, sp gr 2.90.
VDA 023	0.18	7.3	0.34	N	7	5	50	N	5	<1	1-m chip sample, hematitic sandstone, sp gr 2.63.
VDA 024	0.35	16.1	0.42	5	5	20	150	N	5	<1	1-m chip sample, hematitic sandstone, sp gr 2.68.
VDA 025	0.32	18.3	0.42	5	5	20	70	N	10	<1	2-m chip sample, hematitic sandstone, sp gr 2.94.
VDA 026	0.28	17.0	0.40	N	5	5	50	N	5	<1	1-m chip sample, hematitic sandstone, sp gr 2.91.
VDA 027	0.57	16.2	0.38	5	5	30	100	N	25	<1	1-m chip sample, hematitic sandstone, sp gr 2.86.
VDA 028	0.47	14.8	0.40	10	5	30	150	N	20	<1	1-m chip sample, hematitic sandstone, sp gr 2.85.
VDA 038	0.62	20.9	0.55	5	L	20	200	N	15	<1	2-m chip sample, hematitic sandstone, sp gr 2.93.
VDA 039	0.45	18.6	0.52	5	L	15	70	N	5	<1	2-m chip sample, hematitic sandstone, sp gr 2.95.
VDA 040	0.68	11.2	0.35	15	7	30	150	N	25	<1	3-m chip sample, hematitic sandstone and shale, sp gr 2.81.
VDA 041	0.55	19.3	0.70	5	L	15	150	N	10	<1	2-m chip sample, hematitic sandstone, sp gr 2.94.
VDA 042	0.71	10.7	0.33	10	5	30	70	N	20	<1	2-m chip sample, hematitic sandstone, sp gr 2.77.
VDA 043	0.44	14.3	0.38	N	L	7	70	N	5	<1	1-m chip sample, hematitic sandstone, sp gr 2.87.
VDA 046	0.82	3.9	0.36	50	30	100	1000	20	40	<1	1-m chip sample, grayish-red shale, sp gr 2.52.
VDA 049	0.48	18.7	0.50	10	L	20	70	N	15	<1	1-m chip sample, hematitic sandstone, sp gr 2.96.
VDA 050	0.29	16.5	0.43	5	L	10	150	N	5	<1	2-m chip sample, hematitic sandstone, sp gr 2.84.
VDA 060	0.51	16.0	0.48	5	L	10	100	N	15	1	1-m chip sample, hematitic sandstone, sp gr 3.22.
VDA 067	0.43	21.1	0.65	5	L	10	100	N	10	1	0.5-m chip sample, hematitic sandstone, sp gr 2.99.
VDA 069	0.76	18.5	0.47	10	L	20	100	N	30	<1	2-m chip sample, hematitic sandstone, sp gr 2.98.
VDA 073	0.36	16.3	0.37	5	5	15	150	N	10	<1	1-m chip sample, hematitic sandstone, sp gr 2.94.
VDA 077	0.29	15.9	0.39	5	N	15	70	N	5	<1	2-m chip sample, hematitic sandstone, sp gr 2.88.
VDA 078	0.73	13.1	0.53	10	5	20	100	N	15	<1	1-m chip sample, hematitic sandstone, sp gr 2.89.
VDA 079	0.34	14.3	0.37	N	5	10	70	N	10	<1	2-m chip sample, hematitic sandstone, sp gr 2.89.
VDA 223	0.90	16.3	0.52	5	7	15	100	N	20	<1	2-m chip sample, hematitic sandstone, sp gr 2.66.
VDA 226	0.34	15.7	0.39	N	L	7	70	N	10	<1	2-m chip sample, hematitic sandstone, sp gr 2.67.
VDA 227	0.42	17.0	0.45	N	5	7	300	N	10	1	1-m chip sample, hematitic sandstone, sp gr 2.91.
VDA 235	0.49	17.0	0.40	5	5	20	100	N	15	<1	2-m chip sample, hematitic sandstone, sp gr 2.99.
				LIMONITIC SANDSTONE (Oriskany iron ore)							
VDA 032	0.67	58.8	1.80	100	15	150	700	200	[1] 5100	8	0.3-m chip sample, limonite.
VDA 047	0.24	57.1	0.58	70	10	150	500	70	[1] 6700	2	Composite sample, sandy limonite, sp gr 2.72.
VDA 048	0.42	17.6	0.45	10	30	70	500	N	[1] 430	1	2-m chip sample, limonite-cemented sandstone, sp gr 2.63.
VDA 052	1.10	33.5	1.30	20	100	100	300	150	[1] 1200	9	2-m chip sample, limonite-cemented sandstone, sp gr 2.93.
VDA 053	1.69	51.0	1.60	30	50	150	300	100	[1] 1900	22	1-m chip sample, sandy limonite sp gr 2.92.
VDA 055	0.14	57.1	0.46	70	5	150	500	50	[1] 2900	1	1-m chip sample, sandy limonite, sp gr 3.14.
VDA 059	0.31	15.0	0.96	10	10	70	200	20	[1] 550	1	2-m chip sample, limonite-cemented sandstone.
VDA 256	--	[2] 20	--	50	7	100	200	30	510	<1	Composite sample, limonite, sp gr 3.20.
VDA 257	--	[2] 15	--	70	L	150	500	20	190	10	Composite sample, limonite and limonitic sandstone, sp gr 2.33.

[1] Zinc in limonite determined by ICP methods.

[2] Iron determined by semiquantitative spectrographic analyses.

Table 2.--*Analyses of miscellaneous rock samples containing high concentrations of one or more elements*

[All analyses by semiquantitative optical emission spectrographic methods by Shannon Gore, Specomp Services, Inc., Hayden, Colo. except zinc, which is by atomic-absorption methods by B. F. Arbogast and J. D. Sharkey, USGS laboratories, Denver, Colo., uranium, which is by spectrofluorometric methods by J. D. Mensik, Geoco, Inc., Wheat Ridge, Colo., and one phosphorus analysis by inductively-coupled plasma methods using aqua regia digestion, by J. M. Motooka, USGS laboratories, Denver, Colo. Spectrographic data reported as six steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, 0.15, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. Symbols used: N, not detected; L, amount detected is below the lower limit of determination, which is number shown below element symbol; G, greater than value shown; --, not determined.]

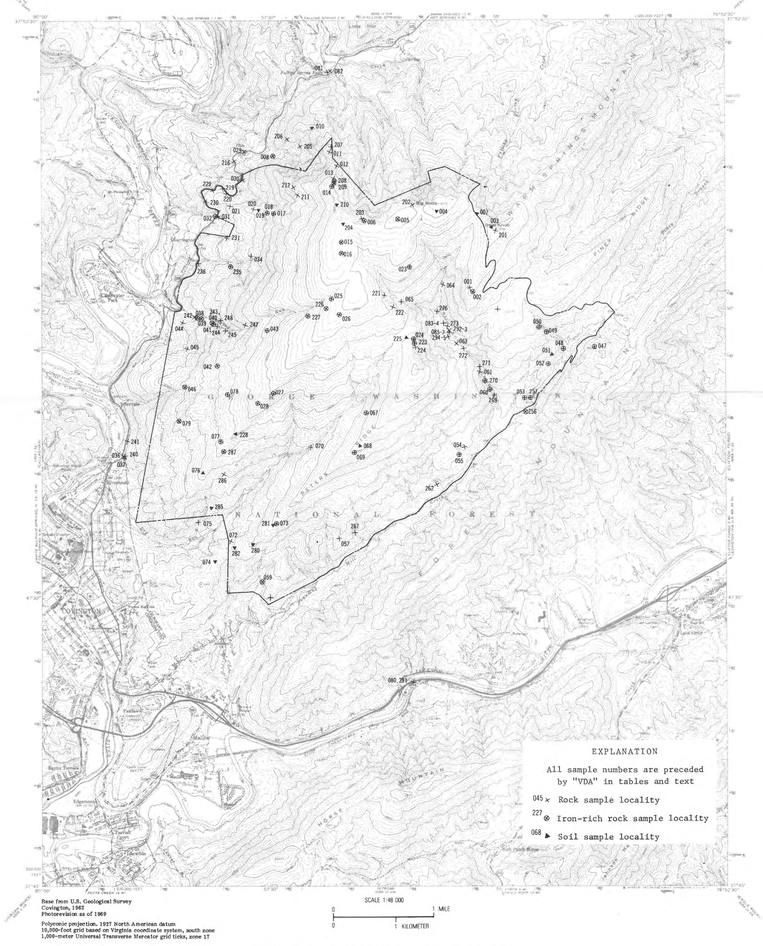
Sample No.	Al	Fe	P	Ag (0.5)	Co (5)	Cu (5)	Mn (10)	Mo (5)	Ni (5)	Pb (10)	Zn	U	Sample description
	Percent			Parts per million									
VDA 030	2	0.5	--	N	N	5	300	N	L	L	160	1	0.6-m chip sample, cherty limestone, Licking Creek Limestone.
VDA 036	2	0.5	--	N	N	L	300	N	15	100	100	<1	1-m chip sample, fossiliferous limestone, Licking Creek Limestone.
VDA 044	2	1.5	--	0.5	15	10	70	N	30	300	85	2	0.5-m chip sample, weathered quartzose sandstone, Keyser Limestone.
VDA 054	3	1.5	--	N	N	5	700	N	20	L	640	<1	2-m chip sample, shaly limestone, Tonoloway Limestone.
VDA 063	7	3	0.54	N	20	30	1000	N	50	50	50	<1	2-m chip sample, phosphatic siltstone, Martinsburg Shale.
VDA 075	4	0.7	--	N	N	5	700	N	30	150	480	<1	1-m chip sample, shaly limestone, Tonoloway Limestone.
VDA 216	7	2	--	N	15	100	300	N	70	70	320	2	1-m chip sample, shale, Romney Shale.
VDA 219	7	2	--	N	10	50	300	N	100	30	210	<1	1-m chip sample, shale, Romney Shale.
VDA 230	6	3	--	N	20	100	1500	N	70	30	60	<1	1-m chip sample, shale, Romney Shale.
VDA 236	1	0.3	--	N	N	L	500	N	N	L	180	<1	1-m chip sample, shaly limestone, Licking Creek Limestone.
VDA 241	7	5	--	2	5	100	70	30	30	70	110	4	1-m chip sample, shale, Romney Shale.
VDA 262	1	1	--	N	100	10	G5000	N	70	20	130	1	1-m chip sample, friable sandstone, Keyser Limestone.
VDA 276	7	3	--	0.5	30	150	1500	N	70	70	80	<1	1-m chip sample, siltstone Martinsburg Shale.
VDA 291	1	0.2	--	N	N	L	500	N	5	30	550	<1	1-m chip sample, cherty limestone, Licking Creek Limestone.

Base from U.S. Geological Survey
Covington, 1962
Photorevision as of 1969
Polyconic projection. 1927 North American datum
10,000-foot grid based on Virginia coordinate system, south zone
1,000-meter Universal Transverse Mercator grid ticks, zone 17

SCALE 1:48 000

Geology simplified from Lesure (1981)

Figure 2.—Small drainage basins and localities of stream-sediment samples.



Base from U.S. Geological Survey
Covington, 1962
Photorevision as of 1969
Polyconic projection. 1927 North American datum
10,000-foot grid based on Virginia coordinate system, south zone
1,000-meter Universal Transverse Mercator grid ticks, zone 17

SCALE 1:48 000

Figure 3.—Localities of rock and soil samples.

EXPLANATION OF MAP UNITS

Qa, Qlc	Holocene	Quaternary	Cenozoic
UNCONFORMITY			
Dr	Middle Devonian	Devonian	Paleozoic
DSu	Lower Devonian Upper Silurian		
Sk	Middle Silurian	Silurian	
Sr			
St	Lower Silurian		
Oj	Upper Ordovician	Ordovician	
Om	Middle Ordovician		

DESCRIPTION OF MAP UNITS

(Note: The following explanation is for the screened geologic base map used with figures 2, and 5.)

Qa	Alluvium (Holocene)—Sand and gravel containing abundant boulders and cobbles of sandstone
Qlc	Landslide and colluvium (Holocene)—Large chaotic masses of boulders, cobbles, and pebbles of quartzite and hematitic sandstone, mostly from the Keefer Sandstone and Rose Hill Formation. Mapped where most obvious and in areas where contacts of underlying formations are completely hidden
Dr	Romney Shale (Middle Devonian)—Shale, black, fissile, pyritic, sparsely fossiliferous. Grades into shale, medium- to light-olive-gray, calcareous, fossiliferous in lower 100 ft. Black shale correlates with lower part of Millboro Shale, and lower gray shale correlates with Needmore Shale
DSu	Lower Devonian and Upper Silurian rocks, undivided—Contains the following formations which are poorly exposed and cannot be mapped separately in this area: Ridgeley Sandstone (Lower Devonian). Sandstone, medium- to coarse-grained, calcareous. Where cemented by secondary iron oxides, forms hanging wall of Oriskany iron deposits Licking Creek Limestone[1] (Lower Devonian). Limestone, upper part light-gray, sandy; where replaced by secondary iron oxides, forms Oriskany iron deposits. Lower part, dark- to medium-gray, cherty; forms footwall of Oriskany iron deposits Healing Springs Sandstone (Lower Devonian). Sandstone, light-gray to grayish-orange, medium- to coarse-grained, crossbedded, calcareous. Deeply weathered and poorly exposed New Creek Limestone (Lower Devonian). Limestone, light- to medium-gray, coarse-grained, crinoidal, sandy. Deeply weathered and poorly exposed Keyser Limestone (Lower Devonian and Upper Silurian). Limestone, medium- to dark-gray, nodular, fossiliferous, cherty; some argillaceous layers contain thin nodules and lenses of black chert. Deeply weathered and poorly exposed. Includes the Clifton Forge Sandstone Member (Lower Devonian) near base. Sandstone, white to light-gray, fine- to coarse-grained, crossbedded, calcareous, fossiliferous Tonolway Limestone (Upper Silurian). Limestone, light-olive-gray to medium-gray, thin-bedded, laminated, impure and argillaceous. Mudcracks, intraformational breccias, and thin, coarse-grained beds, locally. Weathers readily to grayish-yellow shaly chips. Deeply weathered and poorly exposed Williamsport Sandstone(?) or Wills Creek Shale(?) (Upper Silurian). Sandstone, white to brown, porous, calcareous, crossbedded; interbedded light-gray shale and minor amounts of pale-yellow-orange, friable, silty sandstone in lower part. Deeply weathered and poorly exposed. Called "Wills Creek" Formation by Lesure (1957, p. 39). Exposures are too poor to correlate this unit with better exposed sections outside the area
Sk	Keefer Sandstone (Middle Silurian)—Sandstone, white to light-gray, very fine- to fine-grained, nearly pure quartz. Thin- to thick-bedded and locally crossbedded. Weathered surfaces commonly stained red, pink, or brown. Generally unfossiliferous except for *Scolithus* tubes
Sr	Rose Hill Formation (Middle Silurian)—Sandstone, dusky-red-purple, hematitic, thin- or thick-bedded, crossbedded, interbedded greenish-gray to moderate-red shale. Sandstone forms abundant slabby float that conceals softer and more easily eroded shale beds. Hematitic beds are low-grade iron resource. Some thin beds, 0.5-2 ft (0.1-0.6 m) thick, of fossiliferous, oolitic, hematitic sandstone were mined for iron locally east and south of the area
St	Tuscarora Quartzite (Lower Silurian)—Quartzite, white to light-gray, fine- to coarse-grained, conglomeratic near base. Generally medium- to thick-bedded and locally crossbedded. Resistant to erosion
Oj	Juniata Formation (Upper Ordovician)—Sandstone, mostly grayish-red, but some light-gray to olive-gray, very fine-grained, thin-bedded, crossbedded, micaceous; interbedded grayish-red and olive-gray silty shale
Om	Martinsburg Shale (Upper and Middle Ordovician)—Shale, medium- to light-gray, medium-grained, calcareous; interbedded argillaceous limestone. Weathers to grayish-yellow and yellowish-orange shale chips

Contact—Approximately located; dashed where covered by Quaternary deposits

Strike and dip of beds

15	Inclined
⊕	Horizontal
80	Overturned
	Vertical

Boundary of study area

Iron mine

⚒	Abandoned open cut or group of cuts
X	Prospect pit or small cut

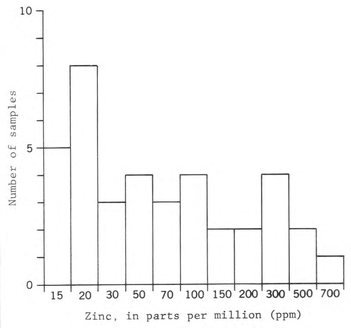
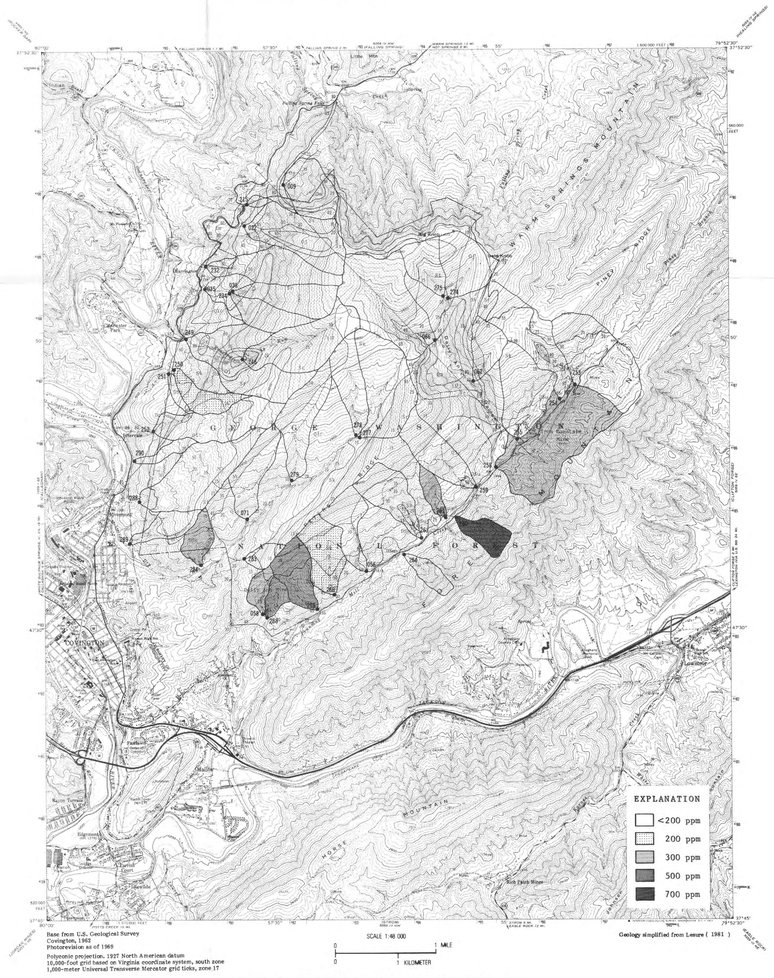


Figure 4.—Histogram showing distribution of zinc in stream sediments. Data grouped in six steps per order of magnitude (Motooka and Grimes, 1976, p. 2).



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Covington, 1962
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1,000-meter Universal Transverse Mercator grid ticks, zone 17

SCALE 1:48 000

0 1 MILE
0 1 KILOMETER

Geology simplified from Lesure (1981)

Figure 5.—Distribution of zinc in stream sediments.

STUDIES RELATED TO WILDERNESS

Roadless Areas

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geochemical survey of the Dolly Ann Roadless Area in the George Washington National Forest, Alleghany County, Va. The area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

INTRODUCTION

The U.S. Geological Survey (USGS) made a reconnaissance geochemical survey of the Dolly Ann Roadless Area (fig. 1) to test for indistinct or unexposed mineral deposits that might be recognized by their geochemical halos. Similar geochemical surveys based on trace-element analyses have been credited with the discovery of many types of mineral deposits (Hawkes and Webb, 1962). No metallic mineral deposits other than iron and manganese are known in the sequence of rocks exposed in the study area, and no evidence of any other deposit was found in the geochemical studies. Samples collected by the author, assisted by M. B. Longacre in May 1979 and A. E. Grosz in April 1980, include 39 stream sediments, 17 soils, and 120 rocks.

PROCEDURES

Most of the small drainage basins in the study area and a few adjacent to it were sampled by collecting a few handfuls of the finest sediment available (fig. 2). After drying in the laboratory, the samples were sieved, and the minus 80-mesh (0.007 in. or 0.177 mm) fraction was used for analyses.

The rock samples consist of a few small chips taken from beds of mostly one lithology and of known thickness (fig. 3). The samples are representative of the major rock types exposed in the study area. About one-third are samples of hematitic sandstone from the Rose Hill Formation. Sandstones from the Juniata Formation, Tuscarora Quartzite, and Keefer Sandstone and siltstones from the Martinsburg Shale make up another one-third. The rest are from the poorly exposed Upper Silurian and Lower Devonian formations.

Soil samples were collected, mostly in areas of few outcrops (fig. 3). The soil samples are from the A2 or upper B soil zones, just below the dark, organic-rich surface soil (A_1 zone).

All samples were scanned spectrographically for 34 elements and analyzed chemically for zinc and uranium. The iron-rich samples were analyzed separately for iron and phosphorus. The complete analytical data and rock sample descriptions are given in Lesure and others (1981). Tables 1 and 2 give the concentrations of selected elements in the iron-rich samples and in some miscellaneous rock samples having high concentrations of one or more elements.

DISCUSSION

A summary of the analytical data for samples from the Dolly Ann Roadless Area is compared with the median values for analyses on similar samples collected in Mill Creek, Mountain Lake, and Peters Mountain Wilderness Study Areas, Craig and Giles Counties, Va., and Monroe County, W. Va. (table 3). These three study areas, which are about 40-55 mi (64-88 km) southwest of Covington, have the same rock formations exposed as in Dolly Ann. The median concentrations of many elements for all sample types in Dolly Ann are as similar to those from Mill Creek, Mountain Lake, and Peters Mountain as can be expected considering that the data are semiquantitative and that the analyses were done by different analysts using different machines and techniques. The analytical data indicate areas rich in iron; they do not indicate any other well-defined anomalous areas obviously related to mineralized rock.

The sandy limonite deposits in the Licking Creek Limestone and Ridgeley Sandstone, the so-called Oriskany iron ores (Lesure, 1957, p.80-105), also contain zinc in amounts ranging from 190 to 6,700 parts per million (ppm) (table 1). The zinc content is typical for this type of iron deposit in Virginia and may have accumulated with the iron during weathering and ore formation. Zinc has long been reported as a minor constituent of these ores (Benton, 1886, p. 283) and was considered a nuisance in the early smelting operations (Firmstone, 1879; Means, 1889). Samples of unweathered Licking Creek Limestone and weathered Romney Shale contain 60-550 ppm zinc (table 2). Unweathered calcareous sandstone of the Lower Devonian rock that crops out about 3 mi (5 km) northeast of White Sulfur Springs, Greenbrier County, W.Va., and about 15 mi (24 km) west of Covington, locally contains as much as several percent zinc (Lesure and others, in press). The zinc is not considered to be of resource value.

A few of the stream-sediment samples contain high concentrations of zinc (figs. 4 and 5). The areas from which these samples were collected seem to be related to areas containing limonite deposits or the Upper Silurian and Lower Devonian limestones that contain traces of zinc.

The limonite deposits also contain trace amounts of cobalt, nickel, manganese, and uranium (table 1). The type of strong, tough cast iron, containing 0.184 percent combined nickel and cobalt, reported by Firmstone (1909, p. 548) to have been produced from typical Oriskany iron ore probably is responsible for iron from this area being a favorite of the Tredegar Iron Works in Richmond for use in naval ordnance (Bruce, 1931, p. 119, 190).

All but one sample of limonitic sandstone contain traces of uranium (U) ranging from 1 to 22 ppm (table 1). A few other rock samples also have traces of uranium (table 2). All the soil samples have less than 1 ppm U, and only 5 stream-sediment samples contain traces of it. Sample nos. VDA 035, VDA 234, and VDA 250 contain 1 ppm U; sample no. VDA 260 has 2 ppm U; and sample no. VDA 264 has 3 ppm U. Both samples 260 and 264 are from small drainage basins containing limonite iron mines. None of these uranium concentrations appears to have any economic significance.

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Turekian, K. K., and Wedepohl, K. H., 1961, Distribution of the elements in some major units of the earth's crust: Geological Society of America Bulletin, v. 72, no. 2, p. 175-192.

Table 3.--*Range and median concentrations of 28 elements in rock, stream-sediment, and soil samples from Dolly Ann Roadless Area and vicinity compared with the median values for similar samples from the Mill Creek, Mountain Lake, and Peters Mountain Wilderness Study Areas, Craig and Giles Counties, Va., and Monroe County, W. Va.*

[All analyses of Dolly Ann samples by seimquantitative optical-emission spectrographic methods by Shannon Gore, Specomp Services, Inc., Hayden, Colo., and D. F. Siems, USGS laboratories, Denver, Colo., except uranium, which is by spectrofluorometric methods by Geoco, Inc., Wheat Ridge, Colo., and zinc, which is by atomic-absorption by B. F. Arbogast and J. D. Sharkey, USGS laboratories, Denver, Colo. Spectrographic analyses were reported as six steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, 0.15, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. Symbols used: N, not detected;<, amount detected is below the lower limit of determination, which is number shown;>, amount is greater than number shown; —, not determined. Elements looked for spectrographically but not found and their lower limits of determination (ppm): As(200), Au(20), Bi(10), Cd(20), Li(100), Sb(100), and W(50).]

	MARTINSBURG SHALE Calcareous shale and limestone				JUNIATA FORMATION Sandstone				TUSCARORA QUARTZITE Sandstone				ROSE HILL FORMATION Hematitic sandstone & shale				KEEFER SANDSTONE Sandstone				RIDGELEY SANDSTONE AND LICKING CREEK LIMESTONE Limonitic sandstone				ROMNEY SHALE Shale			STREAM SEDIMENTS				SOIL			
	13 samples				7 samples			20 [2] samples	12 samples			72 [2] samples	41 samples			68 [2] samples	11 samples			51 [2] samples	9 samples			31 [2] samples	7 samples			39 samples			203 [2] samples	17 samples			98 [2] samples
Elements	Low	High	Median	Average in shale [1]	Low	High	Median	Median	Low	High	Median	Median	Low	High	Median	Median	Low	High	Median	Median	Low	High	Median	Median	Low	High	Median	Low	High	Median	Median	Low	High	Median	Median
PERCENT																																			
Al	--	--	--	8	1	7	5	1.5	0.5	2	1	0.31	1	7	2	1	0.5	7	1	0.2	1	3	1	0.7	4	7	4	1	6	4	1.5	3	7	5	—
Ca	0.1	>20	15	2.21	<0.05	0.1	<0.05	0.03	N	0.2	<0.05	0.16	N	0.3	0.07	0.1	N	0.1	<0.05	0.012	N	<0.05	<0.05	0.026	<0.05	10	0.07	<0.05	0.5	0.07	0.05	<0.05	0.2	0.07	0.05
Fe	1.5	7	5	4.7	1	2	1.5	1.5	0.05	0.3	0.07	0.48	3	20	15	>23	0.05	2	0.2	0.7	10	>20	20	>23	2	5	3	0.3	5	2	1.5	1.5	3	2	1.25
Mg	0.7	2	2	1.5	0.02	0.5	0.3	0.12	<0.02	0.07	0.025	0.19	<0.02	0.5	0.07	0.093	<0.02	0.3	0.02	0.022	<0.02	0.03	<0.02	0.013	0.2	1.5	0.3	0.05	0.3	0.15	0.1	0.07	0.5	0.15	0.1
Na	--	--	--	0.96	N	1	0.5	0.006	N	<0.15	N	<0.005	N	0.7	N	<0.005	N	0.5	N	<0.005	N	0.15	N	<0.005	0.3	1	0.7	N	0.7	0.2	0.02	0.15	0.5	0.3	--
Ti	0.07	0.7	0.5	0.46	0.1	0.5	0.3	0.68	0.02	0.3	0.06	0.74	0.05	0.3	0.1	0.12	0.015	0.5	0.5	0.055	0.01	0.07	0.03	0.02	0.1	0.7	0.3	0.1	0.5	0.3	0.15	0.2	>1	0.7	0.5
PARTS PER MILLION																																			
Ag	N	0.5	N	0.07	N	N	N	<0.4	N	0.5	N	<0.4	N	N	N	<0.4	N	0.5	N	<0.4	N	N	N	<0.4	N	0.5	N	N	N	N	<0.4	N	N	N	N
B	10	150	100	100	N	30	15	70	N	20	<10	70	10	70	30	72	N	70	10	95	15	30	20	<14	30	70	70	10	70	50	70	10	50	20	70
Ba	50	700	500	580	100	300	200	150	N	150	50	54	N	500	150	150	N	700	20	40	N	700	300	110	200	700	500	20	500	300	150	100	700	300	200
Be	<1	5	2	3	1	3	1	<1	N	1	<1	<1	<1	3	2	2	N	5	<1	<1	7	30	10	4	1	7	3	1	10	3	2	<1	3	1	<1
Co	10	30	20	19	N	15	5	2	N	N	N	<1	N	50	5	2	N	10	N	<1	10	100	50	12	5	20	10	N	70	20	10	N	50	10	<5
Cr	20	100	70	90	20	70	30	19	10	30	15	11	20	150	50	30	10	70	10	8	20	200	30	18	50	150	150	10	100	50	20	30	150	70	20
Cu	5	150	30	45	5	30	7	6	N	5	<5	1	N	30	5	3	N	15	<5	<1	<5	100	10	46	20	100	50	N	50	10	15	5	20	10	5
La	20	150	70	92	N	70	20	14	N	N	N	13	20	150	100	48	N	100	N	5	20	100	50	<4	50	150	70	N	150	50	20	50	150	100	<20
Mn	500	2000	1500	850	15	300	100	110	N	500	10	64	30	1000	70	100	N	200	30	89	200	700	500	210	30	3000	300	70	3000	1000	500	50	3000	500	150
Mo	N	10	N	2.6	N	N	N	<1	N	N	N	<1	N	N	N	<1	N	N	N	<1	N	N	N	<1	N	30	N	N	N	N	<1	N	N	N	<5
Nb	N	10	<10	11	N	10	10	<10	N	10	N	<10	N	10	10	12	N	10	N	<10	N	N	N	<10	N	10	10	N	20	10	<10	N	50	20	<20
Ni	7	70	50	68	7	30	20	11	5	10	7	4	<5	100	15	11	<5	30	7	4	50	150	100	86	15	100	50	7	150	30	10	5	50	20	7
Pb	10	70	20	20	10	50	10	<6	10	70	20	<6	N	20	N	16	10	30	20	10	N	200	50	35	N	70	30	10	200	30	20	20	100	30	10
Sc	5	30	15	13	N	10	5	2	N	N	N	1	N	20	10	11	N	20	N	1	N	15	N	5	5	30	20	N	20	10	3	5	30	15	7
Sn	N	N	N	6	N	N	N	<15	N	N	N	<15	N	N	N	<15	N	N	N	<15	N	N	N	<15	N	10	N	N	15	N	<15	N	N	N	<15
Sr	<100	1000	200	300	N	<100	<100	24	N	N	N	6	N	200	100	150	N	<100	N	5	N	100	<100	8	N	100	100	N	200	100	20	N	200	<100	N
Th	N	N	N	12	N	N	N	<21	N	100	N	<21	N	100	N	51	N	N	N	<21	N	N	N	<21	N	N	N	N	N	N	<21	N	N	N	--
U	[3] <1	[3] <1	[3] <1	3.7	<1	1	<1	--	<1	<1	<1	--	<1	4	<1	—	<1	<1	<1	—	<1	22	2	--	<1	4	<1	<1	3	<1	--	<1	<1	<1	--
V	30	200	150	130	15	70	70	23	N	30	10	7	70	150	100	85	N	100	10	6	15	100	30	50	<10	300	200	15	100	70	30	70	150	70	50
Y	15	70	30	26	10	50	30	18	N	20	N	11	20	700	70	63	N	70	N	9	20	100	50	13	30	70	70	10	70	50	20	30	70	70	25
Zn	20	120	60	95	<5	35	15	<14	N	10	<5	<14	5	60	10	50	<5	40	10	<14	[4] 430	[4] 6700	[4] 1200	580	10	320	95	15	690	50	<15	15	110	30	40
Zr	20	300	150	160	50	700	300	360	N	700	100	770	100	700	300	810	50	1000	300	820	20	200	50	140	50	300	100	100	1000	300	300	200	>1000	700	500

[1] Turekian and Wedepohl (1961).

[2] Lesure and others (in press, table 1).

[3] Only 4 samples analyzed for uranium.

[4] ICP analyses on 7 samples, see table 1.

GEOCHEMICAL SURVEY OF THE DOLLY ANN ROADLESS AREA, ALLEGHANY COUNTY, VIRGINIA

By

Frank G. Lesure

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